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Distribution, Abundance, and Breeding Activities of the Least Bell's Vireo along the San Diego River, California

2010 Annual Data Summary

Prepared for:

San Diego River Conservancy

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
WESTERN ECOLOGICAL RESEARCH CENTER

Distribution, Abundance, and Breeding Activities of the Least Bell's Vireo along the San Diego River, California

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U.S. GEOLOGICAL SURVEY
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EXECUTIVE SUMMARY

Surveys for the endangered Least Bell's Vireo (*Vireo bellii pusillus*) were conducted along the San Diego River between 20 March and 18 June 2010. Riparian habitat suitable for vireos from Interstate 5 to the El Capitan Reservoir was surveyed three times. Ninety territorial male vireos were detected, 49 (54%) of which were confirmed as paired. Four transient vireos were also detected.

Most (92%) vireo territories occurred in four of six sections surveyed: Santee (29%), Park (23%), Gorge (22%), and Lakeside (18%). The Valley survey section contained six vireo territories (7%) and one vireo territory (1%) was detected in the El Capitan survey section. The number of territorial Least Bell's Vireos detected in 2010 increased 10% from 2009. Vireo numbers increased in four of the six survey sections, with the largest increase in the Gorge area (67%).

The majority of vireo territories occurred in habitat characterized as mixed willow (*Salix* spp.) riparian, with 51% of territories in the study area found in this habitat. Forty percent of territories occurred in willow habitat co-dominated by cottonwoods (*Populus fremontii*), and two territories each occurred in willow habitat co-dominated by sycamores (*Platanus racemosa*), riparian scrub, upland scrub, and non-native vegetation.

Of the 144 vireos (males and females) detected in 2010, 27 were color banded prior to 2010, 5 were recaptured with single numbered bands and given color combinations in 2010, and 2 unbanded vireos were captured and given color combinations. Four other vireos were banded with a single numbered light blue metal band indicating that they had been banded as nestlings in the study are in 2008 or 2009 but we were unable to capture them to determine their identities or give them color combinations. Fifty-seven nestlings were banded with a single numbered federal band for the first time in 2010.

Sixty-nine percent (72% of males and 50% of females) of adult vireos banded prior to 2010 returned to the San Diego River in 2010. Three additional adult vireos that were not detected in 2009 were observed in 2010. Of these three, two fledged from nests in 2008 on the San Diego River and the San Luis Rey River. The third was an adult male that was last detected in 2008 and returned to occupy the same territory in 2010. The detection of these adult vireos increased first-year survivorship for 2008-2009 to 17% and adult survivorship for the same years to 80%. Three of the 35 hatch-year banded vireos that survived to fledge in 2009 returned in 2010 for a first-year survivorship of 9% (6% for males and 11% for females). Survival rate for adults at the Treatment site was 72% (86% for males and 25% for females) and at the Reference site was 71% (69% for males and 100% for females).

Eighty-five percent of returning adults occupied the same territory that they had occupied in 2009 or the territory adjacent to their 2009 territory. The remaining 15% of adult vireos moved 1.0-3.2 km from their 2009 territories to their 2010 territories. The average distance first-year vireos dispersed from the San Diego River to all sites was 4.2 ± 4.6 km (SD) (n = 3).

A single banded Southwestern Willow Flycatcher (*Empidonax traillii extimus*) was detected in the Valley survey area in early June where it remained for approximately 3 weeks.

The flycatcher was recaptured and given a complete color band combination; it was originally banded 61.7 km to the north on Marine Corps Base Camp Pendleton in 2009 as a nestling.

Nesting activity was monitored in 23 territories, 13 within the Treatment site where Brown-headed Cowbirds (*Molothrus ater*) were trapped and 10 within the Reference site, where no cowbirds were trapped. Cowbird traps were open from 1 April through 31 May. A total of 59 nests were monitored during the breeding season; however, 3 of these were not completed and were excluded from calculations of nest success and productivity. Most pairs had initiated their first nest by the end of April and 84% of pairs attempted at least two nests in 2010. One pair successfully fledged two broods in 2010.

Parasitism by Brown-headed Cowbirds occurred at both sites. The rate of cowbird parasitism has decreased each year from 2008 to 2010 and has been consistently higher at the Reference site than the Treatment site. The only cowbird parasitism event at the Treatment site occurred more than three weeks after cowbird traps were closed. At the Reference site, cowbird parasitism averaged 75% of nests after the first incident in the second week of May. Forty-three percent of parasitized nests contained at least two cowbird eggs (three nests). Five percent of nests failed as a result of cowbird parasitism, while two parasitized nests successfully fledged a total of five young after removal of cowbird eggs by nest monitors.

Twenty-five percent of all completed vireo nests along the San Diego River successfully produced at least one vireo fledgling. If cowbird eggs had not been removed from nests, the nest success rate would have been 21%. Nest success did not differ significantly between Treatment and Reference sites (36% and 14%, respectively). Seventy-five percent of nests were not successful. Predation was believed to be the primary source of nest failure at all sites, accounting for 52% of nest failures. Other causes of nest failure included host plant collapse/structural instability, human destruction, and unknown reasons. Average clutch size was relatively high across all sites and was reduced in nests that experienced cowbird parasitism. The number of vireo young fledged per pair was significantly higher at the Treatment site than at the Reference site.

In 2010, successful and unsuccessful nests within Treatment and Reference sites did not differ statistically in most nest placement characteristics, although successful nests at Reference sites were placed further from the edge of the riparian vegetation than unsuccessful nests. There were no differences in nest placement between nests at Treatment and Reference sites. A total of 14 plant species were used as hosts for vireo nests in 2010. Fifty-two percent of Treatment nests and 85% of Reference nests were placed in mule fat (*Baccharis salicifolia*), red or arroyo willow (*S. laevigata* or *S. lasiolepis*), or black willow (*S. gooddingii*).

INTRODUCTION

The Least Bell's Vireo (*Vireo bellii pusillus*; "vireo") is a small, migratory songbird that breeds in southern California and northwestern Baja California, Mexico from April through July. Historically abundant within lowland riparian ecosystems, vireo populations began declining in the late 1900's as a result of habitat loss and alteration associated with urbanization and conversion of land adjacent to rivers to agriculture (Franzreb 1989, USFWS 1998, RHJV 2004). Additional factors contributing to the vireo's decline have been the expansion in range of the Brown-headed Cowbird (*Molothrus ater*), a brood parasite, to include the Pacific coast (USFWS 1986; Franzreb 1989; Brown 1993; Kus 1998, 1999), and the introduction of invasive exotic plant species, such as giant reed (*Arundo donax*), into riparian systems. By 1986, the vireo population in California numbered just 300 territorial males (USFWS 1986).

In response to the dramatic reduction in numbers of Least Bell's Vireos in California, the California Fish and Game Commission listed the species as endangered in 1980, and the U.S. Fish and Wildlife Service followed suit in 1986. Since listing, the vireo population in southern California has rebounded, largely in response to cowbird control and habitat restoration and preservation (Kus and Whitfield 2005). As of 2006, the statewide vireo population was estimated to be approximately 3,000 territories (USFWS 2006).

The San Diego River has been subject to a number of Least Bell's Vireo surveys and nest monitoring activities over the past 30 years. In 1978, Goldwasser (1978) found 12 vireo territories between Mission Valley and State Route 67. Jones (1985) found 33 vireo territories from just west of the Old Mission Dam to State Route 67 in 1984. Jones assumed that this increase of 21 vireo territories was not an actual increase in vireo numbers but rather an increase in survey effort. This number remained relatively stable through 1988 (SANDAG 1990), and increased to 58 territories by 1997 (Kus and Beck 1998). The increase in vireo numbers occurred concurrently with cowbird control efforts, which were initiated in the Mission Trails Park area in 1984 (Jones 1985).

Natural resource managers on the San Diego River have identified two management activities, giant reed control and cowbird control, that have been effective in enhancing vireo numbers elsewhere and in the past on the San Diego River (Jones 1985, Kus and Whitfield 2005). Both of these management activities have the potential to be expensive in terms of money (e.g., cost of operating cowbird traps annually in perpetuity) and collateral impacts (e.g., short-term reduction of vegetation cover in vireo habitat). Therefore, our project was designed to allow an experimental determination of the most cost- and biologically-effective means to implement these management activities.

Giant reed is a highly invasive, non-native plant within riparian systems in southern California. Originally introduced for bank stabilization in the 1800's, giant reed has become a major component of many riparian systems, becoming the dominant vegetation within streams and rivers. As part of a riparian restoration effort, large quantities of giant reed have been removed from sections of the San Diego River in the past. Areas that have recently undergone giant reed removal tend to consist of patches of native woody plants surrounded by areas of bare

earth. These open areas are typically populated by native and non-native herbaceous plants until the appropriate conditions arise that allow for the establishment of native woody species, such as mule fat, sandbar willow, black willow, arroyo willow, and red willow.

As part of our project, giant reed was removed from the eastern reach of the Valley section of the survey area and the western reach of the Santee section along Carlton Oaks Golf Course in late 2008/early 2009. We surveyed for vireos along the San Diego River drainage from Interstate 5 to El Capitan Dam before and after the giant reed removal to determine how vireo distribution and abundance responded to this management activity.

Brood parasitism by Brown-headed Cowbirds has been identified as one of the leading causes of decline in vireo populations (Kus 1999). Cowbird trapping, in addition to nest monitoring to detect and remove cowbird eggs from vireo nests, has the potential to virtually eliminate parasitism in many populations. Cowbird trapping and vireo nest monitoring were first implemented on the San Diego River in 1984 (Jones 1985), and standardized nest monitoring began in 1986 (G. Collier and B. Jones, unpubl. data). Cowbird trapping was conducted annually from 1987 through at least 1996 (Kus and Whitfield 2005), and also in 2001 through 2007 (Varanus Biological Services 2001, 2003; Varanus Monitoring Services 2004, 2007) in Mission Trails Regional Park.

To determine the effectiveness of various potential cowbird trapping regimes, we monitored vireo nesting activity at two monitoring plots according to the following plan: (year 1) no cowbird trapping; (year 2) cowbird traps operated at one of two monitoring plots from 25 April through 30 July; (year 3 – current year) cowbird traps operated at the same monitoring plot from 1 April through 31 May; (year 4) cowbird traps operated at both monitoring plots from 1 April through 31 May; and (year 5) no cowbird trapping but vireo nesting activity will be monitored at both plots.

Our objectives in this study were to (1) determine abundance and distribution of vireos along the San Diego River to facilitate population trend analyses and response to management activities, (2) band a subset of vireos to aid in the estimation of vireo survivorship and movement for the population as a whole and in response to management activities, (3) assess the effect of giant reed control on vireo abundance and distribution, and (4) assess the short-term effects of varied Brown-headed Cowbird control regimes on vireo fecundity, nest success, and productivity by intensively monitoring vireos within nest monitoring sites. These data, when combined with data from other years, will inform natural resource managers about the status of this endangered species along the San Diego River, and guide modification of land use and management practices as appropriate to ensure the species' continued existence.

This work was funded by the San Diego River Conservancy, San Diego, California.

STUDY AREAS AND METHODS

Natural History

Male vireos arrive on breeding grounds in southern California in mid-March. Male vireos are conspicuous, and frequently sing their diagnostic primary song from exposed perches throughout the breeding season. Females arrive approximately 1-2 weeks after males and are more secretive, but are often seen early in the season traveling through habitat with the male. The female, with the male's help, builds an open cup nest in dense vegetation approximately 1 m above the ground. Clutch size for Least Bell's Vireos average 3-4 eggs. Typically, the female and male incubate the eggs for 14 days and young fledge from the nest at 11-12 days of age. It is not unusual for vireos to re-nest after a failed attempt provided ample time remains within the breeding season. Vireos rarely fledge more than one brood in a season although double-brooding is not uncommon when conditions are favorable (Lynn and Kus 2009, Ferree and Kus 2008). Nesting lasts from early April through July, but adults and juvenile birds remain on the breeding grounds into late September/early October before migrating to their wintering grounds in southern Baja California, Mexico.

Field Surveys

Riparian habitat along the San Diego River from Interstate 5 to El Capitan Reservoir was surveyed for vireos between 20 March and 18 June 2010 (Fig. 1). Field work was conducted by PJ Falatek, Alex Houston, Suellen Lynn, and Ryan Pottinger. The survey area was divided into six sections:

1. ***Valley:*** From Interstate 5 upstream 10.2 km to San Diego Mission Road (Fig.1; Appendix A, Fig. 8).

2. ***Gorge:*** From San Diego Mission Road upstream 6.5 km to Jackson Drive (Fig. 1; Appendix A, Fig. 9).

3. ***Park:*** From Jackson Drive upstream 5.1 km to West Hills Parkway (Fig. 1; Appendix A, Fig. 9).

4. ***Santee:*** From West Hills Parkway upstream 8.1 km to Riverford Road (Fig. 1; Appendix A, Fig. 10).

5. ***Lakeside:*** From Riverford Road upstream 3.9 km to Ashwood Street (Fig. 1; Appendix A, Fig. 11).

6. ***El Capitan:*** From Ashwood Street upstream 11.1 km to the dam at El Capitan Reservoir (Fig. 1; Appendix A, Fig. 12).

Giant reed was removed from the eastern part of the Valley survey section beginning in late 2008 and from the western part of the Santee survey section beginning in late 2009 (Fig. 2).

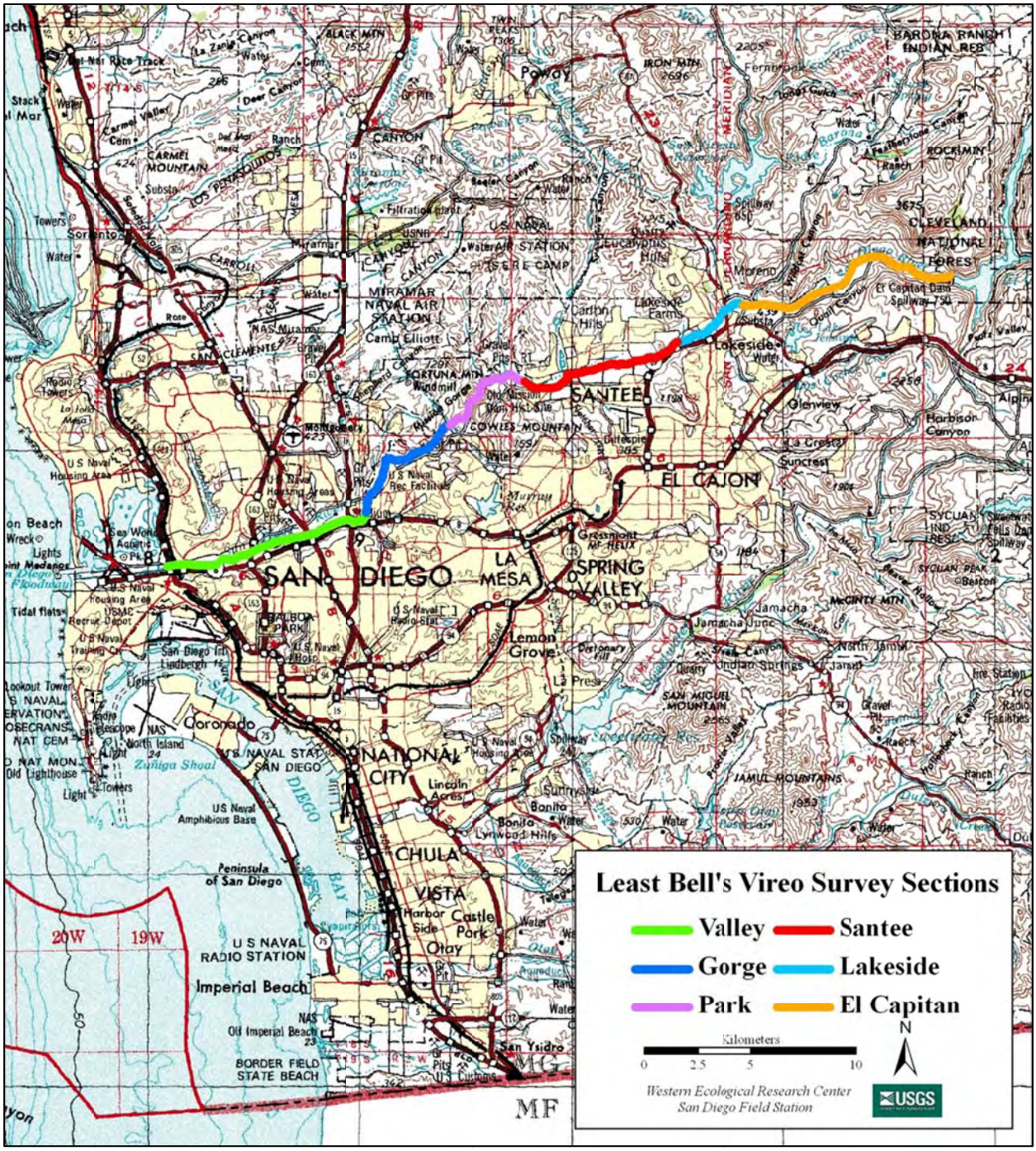

Fig. 1. Least Bell's Vireo survey sections along the San Diego River, 2010.

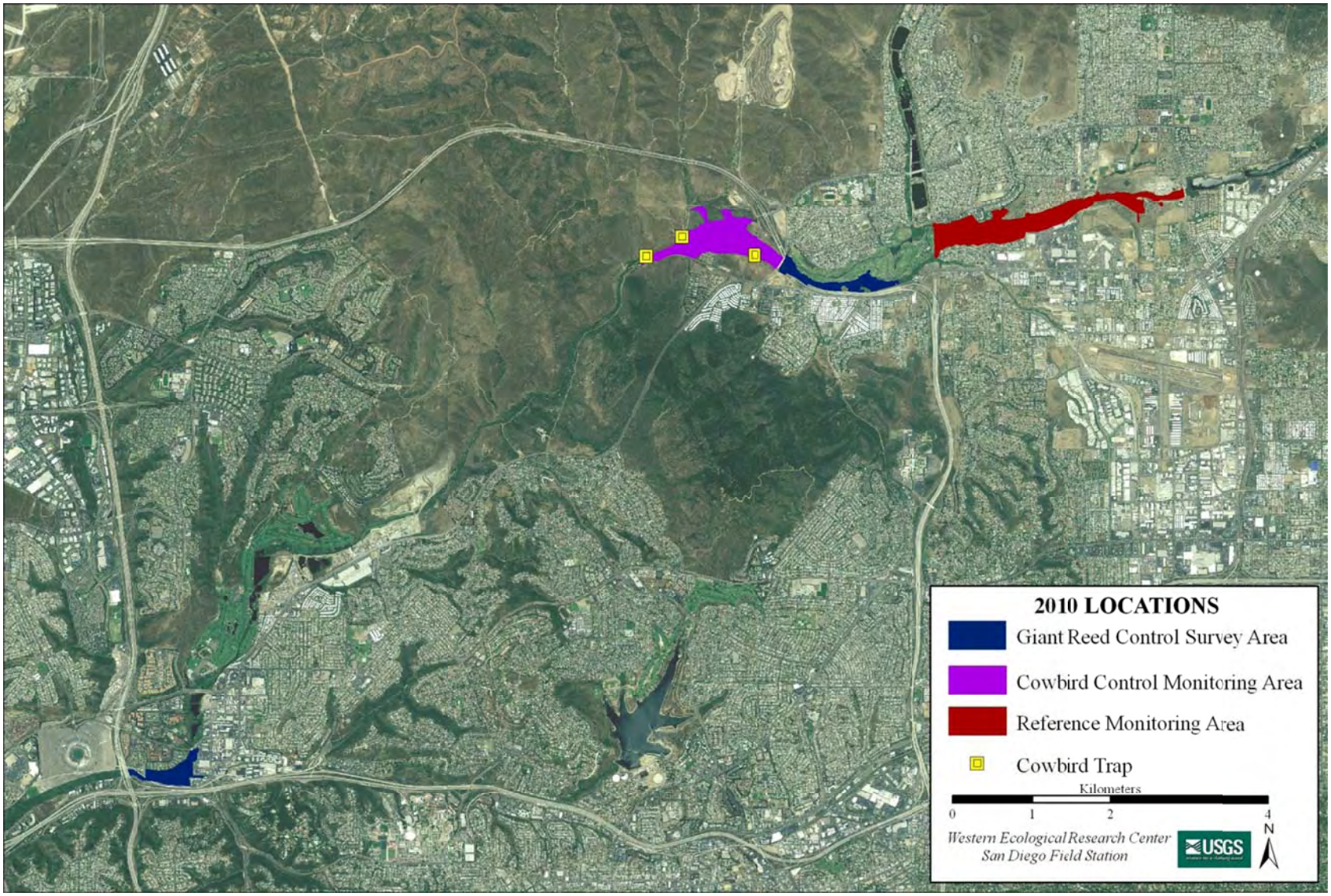

Fig. 2. Location of Least Bell's Vireo nest monitoring areas along the San Diego River, 2010.

Biologists followed standard survey techniques described in the USFWS Least Bell's Vireo survey guidelines (USFWS 2001). Observers moved slowly (1-2 km per hour) through the riparian habitat while searching and listening for vireos. Observers walked along the edge(s) of the riparian corridor on the upland and/or river side where habitat was narrow enough to detect a bird on the opposite edge. In wider stands, observers traversed the habitat to detect all birds throughout its extent. Surveys were conducted between dawn and early afternoon, depending on wind and weather conditions.

All male vireos were detected and confirmed audibly by hearing their diagnostic song. Attempts were made to observe males visually to note banding status but visual identification was not required to confirm the identity of the species as the song was considered the most diagnostic field characteristic. The presence of a female vireo within a territory was confirmed either audibly through the detection of the "pair call" elicited between mated birds, or visually when observed traveling quietly with the male. For each bird encountered, investigators recorded age (adult or juvenile), sex, breeding status (paired, unpaired, undetermined, or transient), and whether the bird was banded. Birds were considered transients if they were not detected again on subsequent surveys after an initial detection. Vireo locations were mapped using a Garmin 12 Global Positioning System (GPS) unit or Garmin GPS 60 unit with 1-15 m positioning accuracy to determine geographic coordinates (WGS84). Dominant native and exotic plants were recorded, and percent cover of exotic vegetation estimated using cover categories of < 5, 5-50, 51-95 and > 95%. The overall habitat type within the territory was specified according to the following categories:

Mixed willow riparian: Habitat dominated by one or more willow species including black willow (*Salix gooddingii*), arroyo willow (*S. lasiolepis*), and red willow (*S. laevigata*), with mule fat (*Baccharis salicifolia*) as a frequent co-dominant.

Willow-cottonwood: Willow riparian habitat in which cottonwood (*Populus fremontii*) is a co-dominant.

Willow-sycamore: Willow riparian habitat in which sycamore (*Platanus racemosa*) is a co-dominant.

Sycamore-oak: Woodlands in which sycamore and oak (*Quercus agrifolia*) occur as co-dominants.

Riparian scrub: Dry and/or sandy habitat dominated by sandbar willow (*S. exigua*) or mule fat, with few other woody species.

Upland scrub: Coastal sage scrub adjacent to riparian habitat.

Non-native: Sites vegetated exclusively with non-native species such as giant reed and salt-cedar (*Tamarix ramosissima*).

Nest Monitoring

We monitored vireos from 29 March through 15 July within two areas, one in which cowbird trapping occurred during our study (hereafter referred to as “Treatment” site, in the Park survey section) and a paired site in which no additional management action occurred (hereafter referred to as "Reference" site, in the Santee survey section; Fig. 2). We attempted to document nesting activity for ten pairs per site throughout the breeding season. Pairs were chosen in order of their detection on-site during the first vireo survey to ensure a complete record of activity within the territory, and attempts were made to monitor the same pairs that had been monitored in previous years.

Pairs were observed for evidence of nesting, and their nests were located. Nests were visited as infrequently as possible to minimize the chances of leading predators or Brown-headed Cowbirds to nest sites; typically, there were 3-5 visits per nest. The first visit was timed to determine the number of eggs laid, the next few visits to document hatching and age of young, and the last to band nestlings. Fledging was confirmed through detection of young outside the nest, or rarely, the presence of feather dust in the nest (SUC). Unsuccessful nests were placed into one of four nest fate categories. Nests found empty or destroyed prior to the estimated fledge date and where the adult vireos were not found tending fledgling(s) were considered depredated (PRE). Previously active nests that were subsequently abandoned by adult vireos after one or more Brown-headed Cowbird eggs were laid in the nest were considered to have failed because of nest parasitism (PAR). Any nests that fledged cowbird young without fledging vireo young were also considered to have failed because of nest parasitism (PAR). Nests failing for reasons such as poor nest construction or the collapse of a host plant that caused a nest’s contents to be dumped onto the ground, or the presence of a clutch of infertile eggs, were classified as failing because of other causes that were known (OTH). Nests that appeared intact and undisturbed but were abandoned with vireo eggs and/or nestlings were classified as having failed because of unknown causes (UNK).

Characteristics of nests were recorded following abandonment or fledging of young from nests. These data included nest height, host species, host height, and the distance nests were placed from the edge of the host plant, the edge of the vegetation clump in which they were placed, and the riparian/upland edge.

In 2010, three cowbird traps were operated from 1 April through 31 May in the Treatment site at the same locations they were operated in 2009 (Sexton 2009, 2010; Fig. 2). We followed our standard protocol for manipulating nest contents in the event cowbird eggs or nestlings were detected in vireo nests. In nests with fewer than three vireo eggs, cowbird eggs were removed no sooner than the seventh day of incubation to minimize the possibility of nest abandonment in response to the removal. Cowbird eggs were removed from nests containing three or more vireo eggs as they were found. Cowbird nestlings were removed immediately from nests. Performed in this way, nest manipulation allows many parasitized nests to remain active and potentially fledge young where they would otherwise fail to fledge vireo young (Kus 1999).

Banding

The primary goals of banding Least Bell's Vireos along the San Diego River were: (1) to better understand adult and juvenile survivorship, site fidelity, and dispersal associated with management actions, and (2) to investigate natal dispersal and the interconnection of vireo populations in San Diego County. Nestlings from monitored nests were banded at 5-7 days of age with a single anodized light blue numbered federal band on the left (or, rarely, right) leg. Adult vireos within Treatment and Reference sites were captured in mist nets and banded with a unique combination of colored plastic and anodized metal bands, including either an anodized light blue or light blue plastic band to designate the San Diego River as the bird's site of origin. Returning adults previously banded as nestlings with a single numbered federal band were target netted to determine their identity, and their original band was supplemented with other bands to generate a unique color combination.

During surveys and nest monitoring activities, we attempted to resight all vireos to determine whether or not they were banded, and if so, to confirm the vireo's identity by reading the unique color band combination or by recapturing birds with single federal bands. We used resighting and recapture data to calculate annual survivorship, or the fraction of all individuals known to be present on the San Diego River in one year that returned the following year. Individuals "known to be present" in a given year included birds observed directly as well as individuals not observed but whose presence was inferred retroactively by their detection in a subsequent year. Imperfect detectability of banded individuals is typical of mark-recapture studies and occurs for various reasons (e.g., females are more cryptic and may be missed on surveys, birds are detected as banded but their full color combinations [and thus identities] are not obtained; birds with single federal bands are not recaptured and thus their identities not determined). Our previous estimates of annual survivorship therefore require adjustment each year to incorporate data for individuals not "seen" previously but known to have been alive.

Survivorship from 2009-2010 was calculated for known individuals that were: (1) adults in 2009 on the San Diego River and were resighted anywhere in 2010; (2) adult vireos that held territories in Treatment or Reference sites in 2009 and were resighted anywhere in 2010; (3) first-year vireos that were banded as nestlings or juveniles anywhere on the San Diego River in 2009 and were resighted anywhere in 2010; and (4) first-year vireos that were banded as nestlings or juveniles in Treatment or Reference sites in 2009 and were resighted anywhere in 2010. Unlike for estimates of overall survivorship of adults and juveniles (i.e., (1) and (3)), we did not adjust survivorship (see above) for analyses involving Treatment and Reference sites because we could not confirm the presence of birds in those sites during years that they were not detected.

Site fidelity and movements of vireos were determined by measuring the distance between the center of a vireo's breeding or natal territory in 2009 and the center of the same vireo's breeding territory in 2010. Vireos exhibited site fidelity if they returned to within 100 m of their 2009 territory. Site fidelity and movement were calculated for the same four categories analyzed for survivorship (see above), except that only individuals with known territory locations during the last year they were detected prior to 2010 were included (e.g., juveniles

banded after fledging were excluded because their natal territories could not be confirmed in light of their capacity for substantial movement).

Data Analyses

We summarized the Treatment and Reference monitoring sites separately to allow comparison between the two sites and between years at each site, before and after management actions occurred. We conducted statistical tests to determine whether there were differences in vireo nest success, productivity, or vegetation characteristics between monitoring sites. We used the Student's *t*-test (or Mann-Whitney *U*-test when data did not meet assumptions for *t*-tests) to determine if there were differences between sites in number of nests completed, clutch size (for parasitized and non-parasitized nests), number of young fledged per pair, nest height, nest host height, and distance from the nest to the edge of the nest host, the edge of the nest vegetation clump, and the edge of riparian vegetation. We also used Mann-Whitney *U*-tests to determine if there were differences between successful and unsuccessful nests in nest height, nest host height, distance from the nest to the edge of the nest host plant, the nest vegetation clump, and the edge of riparian vegetation. We used chi-square analysis (or Fisher's Exact Test when numbers weren't sufficient to perform chi-square analyses) to test for differences in cowbird parasitism rate and nest fate between monitoring sites and between years. We used Pearson's correlation to determine if annual changes in cowbird parasitism were similar between Treatment and Reference sites. To estimate the potential impact(s) of cowbird parasitism on the San Diego River vireo population, we compared two calculations of nest success and productivity: one set including manipulated nests that were eventually successful and the other treating manipulated nests as failed (their likely fate in the absence of nest manipulation). Data were analyzed using SYSTAT statistical software (SYSTAT Software, Inc. 2005). Tests were considered significant if $P < 0.10$.

RESULTS

Population Size and Distribution

Drainage-wide

Ninety-four Least Bell's Vireo sites were identified during surveys (Table 1, Appendix B, Figs. 13-19). This included 90 territorial male vireos, 49 (54%) of which were confirmed as paired, and 4 transients. Transient vireos were observed at two of the six sections surveyed. Four survey sections contained 92% of all male vireos (29% in Santee, 23% in Park, 22% in Gorge, and 18% in Lakeside; Table 1). Six territorial vireos (7%) were detected in the Valley survey section and one territorial vireo (1%) was detected in the El Capitan survey section.

Table 1. Number and distribution of Least Bell's Vireo males along the San Diego River, 2010.

Survey Section	Known Pairs	Single/ Status Undetermined	Total Territorial Males	Transient
Valley	3	3	6	0
Gorge	11	9	20	0
Park	17	4	21	3
Santee	12	14	26	0
Lakeside	6	10	16	0
El Capitan	0	1	1	1
Total	49	41	90	4

The distribution of vireo territories on the San Diego River in 2010 shifted slightly relative to that in 2009, with the number of vireo territories increasing in the upper and lower survey areas and decreasing in the middle areas (Table 2). The vireo population increased in four of the six areas surveyed. One survey area decreased by four vireo territories (13%) and the remaining survey area decreased by two territories (9%) between 2009 and 2010. The area with the largest numeric increase was Gorge, increasing by 67%. Overall, the vireo population on the San Diego River increased by 10% from 2009-2010.

Table 2. Number of territorial male vireos on the San Diego River, by survey area and year, 2008-2010.

	Number of Territorial Males						Numeric/Percent Change	
Survey Area	2008		2009		2010		2009-2010	
Valley	1	2%	3	4%	6	7%	+3	+100%
Gorge	13	21%	12	15%	20	22%	+8	+67%
Park	18	29%	23	28%	21	23%	-2	-9%
Santee	20	32%	30	37%	26	29%	-4	-13%
Lakeside	11	17%	14	17%	16	18%	+2	+14%
El Capitan	0	0%	0	0%	1	1%	+1	+
Total	63		82		90		+8	+10%

Giant Reed Control Sites

In 2008, the year prior to giant reed control at the Valley site, no vireos were detected. During the breeding season following giant reed control at the Valley site, no vireos were present; however, one vireo and one flycatcher (see Incidental Detections below) were detected using the Valley site the second breeding season following giant reed control. In 2009, the year prior to giant reed control at the Santee site, three vireos were detected. During the breeding season following giant reed control at the Santee site, one vireo was present.

Habitat Characteristics

Vireos occupied six habitat types along the San Diego River (Table 3). The majority of vireo territories (51%) occurred in habitat characterized as mixed willow riparian, followed by

willow habitat co-dominated by cottonwoods (40%). Two vireo territories each occurred in willow habitat co-dominated by sycamore, riparian scrub, upland scrub, and non-native vegetation. Similar to 2009, few vireo territories in 2010 contained a large proportion of exotic vegetation (Table 4). These territories contained abundant giant reed, salt-cedar, and black mustard (*Brassica nigra*).

Table 3. Habitat types used by Least Bell's Vireos along the San Diego River, 2010.

	Number of Territories			
Habitat Type	**>50% Native**	**>50% Exotic**	**Total**	**Percent of Total**
Mixed Willow	42	4	46	51%
Willow/Cottonwood	34	2	36	40%
Willow/Sycamore	2	0	2	2%
Riparian Scrub	1	1	2	2%
Upland Scrub	0	2	2	2%
Non-native	0	2	2	2%
Total	79	11	90	100%

Table 4. Proportion of Least Bell's Vireo territories dominated or co-dominated by exotic vegetation, by survey area, 2008-2010. Numbers in parentheses are the number of territories in the survey area.

	Proportion of Territories					
Survey Area	**2008**		**2009**		**2010**	
Valley	0%	(1)	67%	(3)	17%	(6)
Gorge	0%	(9)	0%	(12)	15%	(20)
Park	0%	(18)	0%	(24)	0%	(21)
Santee	0%	(20)	3%	(30)	12%	(26)
Lakeside	9%	(11)	0%	(14)	19%	(16)
El Capitan	0%	(0)	0%	(0)	100%	(1)
Total	2%	(59)	4%	(83)	12%	(90)

Banded Birds

We observed 94 male and 50 female vireos on the San Diego River in 2010, including transients and individuals that were detected in more than one location. We were able to observe 127 adult vireos (88 males, 94% of all males, and 39 females, 78% of all females) well enough to determine banding status in 2010. Thirty-six of these had been banded prior to the 2010 breeding season, 27 of which already had unique color band combinations prior to 2010, 5 of which were "natal" birds, recaptured with a single federal band and given a unique color band combination, and 4 of which were natal and not recaptured (Table 5). The four natal vireos that were not recaptured had light blue numbered federal bands indicating they had been banded in 2008 or 2009 as nestlings on the San Diego River (Tables 5 and 6). Of the 32 known-identity banded birds, 30 were originally banded on the San Diego River (19 in 2008 and 11 in 2009) and

2 were originally banded on the San Luis Rey River as nestlings (1 in 2007 and 1 in 2008). Adult birds of known age ranged from 1-3 years old (Table 6).

Table 5. Banding status of Least Bell's Vireos detected on the San Diego River, 2010.

	Originally Banded on the San Diego River		Immigrated to the San Diego River		
Banding Status	**Male**	**Female**	**Male**	**Female**	**Total**
Uniquely banded prior to 2010	24	2	1	0	27
Natal recaptured in 2010	2	2	0	1	5
Natal (Single numbered metal band)	0	4	0	0	4
Total	26	8	1	1	36

A total of 59 vireos were newly banded along the San Diego River in 2010. Two unbanded adult vireos were captured at their breeding territories in 2010 and given full band combinations (Table 6). Fifty-seven nestlings were banded with a single light blue metal numbered federal band on the left leg.

Table 6. Adult Least Bell's Vireos banded or seen along the San Diego River in 2010.

Yr. Last Detected[a]	Survey Section / Terr. in 2010	Band Combination[b] Left Leg	Band Combination[b] Right Leg	Age in 2010	Sex[c]	Comments[d]
2008	Park / SGPN	WHWH/Mdb	LPBK	2 yrs.	F	Banded as nestling in 2008 on SLR.
2008	Park / PA07	PUYE/Mlb		2 yrs.	M	Banded as nestling in 2008 on SDR.
2009	Park / BTN	LPBK/Mlb		2 yrs.	F	Banded as nestling in 2008 on SDR.
2009	Park / CCO		WHDP/Mlb	1 yrs.	F	Banded as nestling in 2009 on SDR. This female also paired with SGSO in 2010.
2009	Park / BTN	DPDP/Mlb		≥ 3 yrs.	M	Banded as adult in 2008 on SDR.
2009	Park / CCO	LBLB/Mlb		≥ 2 yrs.	M	Banded as adult in 2009 on SDR.
2009	Park / CL6	WHPU/Mlb		2 yrs.	M	Banded as nestling in 2008 on SDR.
2009	Park / EDD		DPWH/Mlb	2 yrs.	M	Banded as nestling in 2008 on SDR.
2009	Park / FJS2		BKLB/Mlb	≥ 2 yrs.	M	Banded as adult in 2009 on SDR.
2009	Park / FRE	WHPU/pupu	Mlb	≥ 2 yrs.	M	Banded as adult in 2009 on SDR.
2009	Park / HTS		YEPU/Mlb	≥ 3 yrs.	M	Banded as adult in 2008 on SDR.
2009	Park / SGPN		PUPU/Mlb	≥ 3 yrs.	M	Banded as adult in 2008 on SDR.
2009	Park / SGPP	Mlb	BKBK/pupu	≥ 3 yrs.	M	Banded as adult in 2008 on SDR.
2009	Park / SGSO	PUPU/Mlb		≥ 3 yrs.	M	Banded as adult in 2008 on SDR.
2009	Park / SGTS	BKBK/Mlb	pupu	≥ 3 yrs.	M	Banded as adult in 2008 on SDR.
2009	Park / WMB2	DPWH/Mlb		≥ 3 yrs.	M	Banded as adult in 2008 on SDR.
2010	Park / TOW	WHDP/Mlb		≥ 1 yrs.	F	Banded as adult in 2010 - TOW territory.
2010	Park / TOW		BKLP/Mlb	≥ 1 yrs.	M	Banded as adult in 2010 - TOW territory.
2008	Santee / SGCA	WHDP/Mlb	pupu	≥ 3 yrs.	M	Banded as adult in 2008 on SDR.
2009	Santee / POR	LPLP/Mlb		≥ 3 yrs.	F	Banded as adult in 2008 on SDR.
2009	Santee / SGCH		WHPU/Mlb	1 yrs.	F	Banded as nestling in 2009 on SDR.
2009	Santee / ALT		LBBK/Mlb	≥ 2 yrs.	M	Banded as adult in 2009 on SDR.
2009	Santee / JOY	Mlb	BKLB/pupu	≥ 2 yrs.	M	Banded as adult in 2009 on SDR.
2009	Santee / LIB	BKBK	Mdb	3 yrs.	M	Banded as nestling in 2007 on SLR.
2009	Santee / MER	PUWH/pupu	Mlb	≥ 3 yrs.	M	Banded as adult in 2008 on SDR.
2009	Santee / POR	YEYE/Mlb		≥ 2 yrs.	M	Banded as adult in 2009 on SDR.
2009	Santee / SA07		PUWH/Mlb	2 yrs.	M	Banded as nestling in 2008 on SDR.

Table 6. Continued.

2009	Santee / SGCA	BKLB/pupu	Mlb	≥ 2 yrs.	M	Banded as adult in 2009 on SDR.
2009	Santee / SGFU	PUYE/Mlb		≥ 3 yrs.	M	Banded as adult in 2008 on SDR.
2009	Santee / SGMA	PUWH/Mlb		≥ 3 yrs.	M	Banded as adult in 2008 on SDR.
2009	Santee / SGSA	Mlb	BYST/pupu	≥ 3 yrs.	M	Banded as adult in 2008 on SDR.
2009	Santee / SPR	LBLB/pupu	Mlb	≥ 2 yrs.	M	Banded as adult in 2009 on SDR.
≤ 2009	Santee / LIB	Mlb		≥ 1 yrs.	F	Banded as nestling before 2010 on SDR.
≤ 2009	Santee / SGCA	Mlb		≥ 1 yrs.	F	Banded as nestling before 2010 on SDR.
≤ 2009	Santee / SGFU		Mlb	≥ 1 yrs.	F	Banded as nestling before 2010 on SDR.
≤ 2009	Santee / SGMA		Mlb	≥ 1 yrs.	F	Banded as nestling before 2010 on SDR.
2009	Valley / VA01	pupu	PUPU/Mlb	≥ 3 yrs.	M	Banded as adult in 2008 on SDR.
2009	Valley / VA03		PUYE/Mlb	1 yrs.	M	Banded as nestling in 2009 on SDR.

[a] Prior to current year.

[b] Band colors: Mdb = dark blue numbered federal band; Mlb = light blue numbered federal band; pupu = metal purple; BKBK = plastic black; BKLB = plastic black-light blue split; BKLP = plastic black-light pink split; BYST = plastic black-yellow striped; DPDP = plastic dark pink; DPWH = plastic dark pink-white split; LBBK = plastic light blue-black split; LBLB = plastic light blue; LPBK = plastic light pink-black split; LPLP = plastic light pink; PUPU = plastic purple; PUWH = plastic purple-white split; PUYE = plastic purple-yellow split; WHDP = plastic white-dark pink split; WHPU = plastic white-purple split; WHWH = plastic white; YEPU = plastic yellow-purple split; YEYE = plastic yellow.

[c] Sex: F = female; M = male.

[d] SDR = San Diego River, SLR = San Luis Rey River.

Survivorship, Fidelity, and Movement

Drainage-wide Survivorship

The recapture and resighting of banded birds allowed us to determine the rate at which vireos previously documented along the San Diego River returned to hold territories or were resighted in 2010. This is the minimum number of vireos known to survive and does not include all birds that dispersed from the San Diego River drainage or that we may have failed to detect/resight. However, this baseline number can be used to calculate minimum annual survivorship for the vireo population along the river and can be adjusted annually to add in individuals that were not identified in a particular year but were detected in subsequent years (see Methods: Banding).

Adult Survivorship from 2009-2010

Of 42 uniquely color banded adult vireos present along the San Diego River during the 2009 breeding season, 69% (29/42) returned to the San Diego River in 2010 (Table 7). Three of the six banded adult female vireos known to be alive in 2009 were resighted in 2010, an over-winter survivorship rate of 50%. Twenty-six of the 36 banded adult male vireos known to be alive in 2009 were resighted in 2010, an over-winter survivorship rate of 72%. The remaining 13 vireos that had full color band combinations in 2009 were not resighted in 2010. The discrepancy in sex-related over-winter survivorship may be attributed to difficulty in resighting females and also the low proportion of females that were banded. In any given year, the proportion of females that are resighted is lower than for males. Therefore, the chances of resighting a particular female are correspondingly smaller.

Table 7. Number of banded adult Least Bell's Vireos detected in 2009 at Treatment sites, Reference sites, and other areas on the San Diego River, and those that were detected in 2010. Numbers in parentheses include the adjustments resulting from vireos that were identified in 2010 but not in 2009.

Year/Sex	Treatment Site	Reference Site	Other Areas	Total
2009				
Male	14	16	4	34 (36)
Female	4	1		5 (6)
Total	18	17	5	39 (42)
2010				
Male	12	11	1	24 (26)
Female	1	1	0	2 (3)
Total	13	12	1	26 (29)

First-year Survivorship from 2009-2010

Three of the 35 hatch-year vireos banded in 2009 that survived to fledge were captured and given unique color band combinations on the San Diego River in 2010 (Table 8) yielding a conservative first-year survivorship of 9%. Assuming an equal sex ratio of banded nestlings, first-year survivorship of males was 6% (1/17.5) and females was 11% (2/17.5). Because female vireos are elusive and difficult to recapture, the first-year survivorship estimate may be conservative.

Table 8. Number of Least Bell's Vireos banded as nestlings or fledglings at Treatment sites, Reference sites, and other areas along the San Diego River in 2009, and those that returned in 2010.

Year/Sex	Treatment Site	Reference Site	Other Areas	Total
2009				
Unknown	26	8	1	35
2010				
Male	0	0	1	1
Female	2	0	0	2
Total	2	0	1	3

Adjusted Annual Survivorship

Three banded adult vireos were identified in 2010 that were not detected in 2009. All three had been banded in 2008, two as nestlings (one male on the San Diego River and one female on the San Luis Rey River) and one male as an adult on the San Diego River. These detections increase first-year survivorship for 2008-2009 from 15% to 17% and adult survivorship for the same years from 76% to 80%.

Survivorship at Treatment and Reference Sites

Of the 18 vireos of known sex (14 males and 4 females) that were detected within the Treatment site in 2009, 13 (12 males and 1 female) were resighted in 2010 for a 72% survival

rate (86% for males, 25% for females; Table 7). Of the 17 banded adult vireos of known sex (16 males and 1 female) that were detected within the Reference site in 2009, 12 (11 males and 1 female) were resighted in 2010 for a 71% survival rate (69% for males, 100% for females). No adult vireos moved between Treatment and Reference sites between 2009 and 2010. All but one of the 35 banded juveniles that were known to fledge in 2009 were banded at Treatment or Reference sites. Of these 34, 2 (both females from the Treatment site) were recaptured and given unique color band combinations in 2010 for a first-year survivorship rate of 8% for fledglings from the Treatment site and 0% for fledglings from the Reference site (Table 8).

Drainage-wide Site Fidelity and Movement

Resighting banded birds allowed us to identify individuals that either returned to the same site they used in a previous year (within 100 m) or moved to a different location. Twenty-six adult vireos that were identified in 2009 were resighted in 2010, all of which occupied known territories both years (Table 9). Seventeen adult vireos (65%) that returned in 2010 occupied the same breeding territory that they did in 2009. Five vireos (19%; four males and one female) returned to occupy territories adjacent to their 2009 territories (within 300 m). The remaining four vireos (all males) moved 1.7 ± 1.0 km between their 2009 territories and their 2010 territories (range 1.0–3.2 km).

Three other vireos were not detected in 2009 but were observed in 2008 and detected on the San Diego River in 2010. One female vireo was banded as a nestling on the San Luis Rey River in 2008 and settled in a breeding territory on the San Diego River in 2010, 51.5 km from her natal territory. One male was banded as a nestling on the San Diego River in 2008 and was detected in 2010 occupying a territory 0.9 km from his natal territory. The third vireo not detected in 2009 was an adult male in 2008 that returned to occupy the same territory in 2010. His territory had been occupied by a different vireo in 2009.

The three first-year vireos that had been banded as nestlings along the San Diego River in 2009 and were resighted on the San Diego River 2010 dispersed an average of 4.2 ± 4.6 km from their natal sites (9.3 km for the one male and 0.5-2.7 km for females; Table 9).

Site Fidelity and Movement at Treatment and Reference Sites

Thirteen adult vireos (12 males and 1 female) that were identified at Treatment sites in 2009 were resighted in 2010 (Table 9). Nine of these (eight males and one female) returned in 2010 to occupy the same territory as they did in 2009. Three of the 13 vireos (all males) returned in 2010 to occupy a territory adjacent to their 2009 territory. One male vireo returned in 2010 to occupy a territory 1.09 km from his 2009 territory.

Twelve adult vireos (11 males and 1 female) that were identified at Reference sites in 2009 were resighted in 2010 (Table 9). Six of these (all males) returned in 2010 to occupy the same territory as they did in 2009. Two others (one male and one female) returned in 2010 to occupy a territory adjacent to their 2009 territory. The remaining three male vireos returned in 2010 to occupy territories 1.0 – 3.2 km from their 2009 territories (2.0 ± 1.1 km).

Table 9. Between-year movement of Least Bell's Vireos along the San Diego River.

Year Last Detected	Drainage[a] / Territory / Treatment		Distance Moved	Band Combination[b]		Age in	
	Last Seen	2010	KM	Left Leg	Right Leg	2010	Sex[c]
2009	SDR / STN / REF	SDR / SA07	3.22	-	PUWH/Mlb	2 yrs.	M
2009	SDR / SGHO / REF	SDR / SGMA / REF	1.64	PUWH/Mlb	-	≥ 3 yrs.	M
2009	SDR / ALD / REF	SDR / LIB / REF	1.01	BKBK	Mdb	3 yrs.	M
2009	SDR / POR / REF	SDR / POR / REF	0.11	YEYE/Mlb	-	≥ 2 yrs.	M
2009	SDR / SPR / REF	SDR / SPR / REF	0.09	LBLB/pupu	Mlb	≥ 2 yrs.	M
2009	SDR / SGGR / REF	SDR / VA01	0.06	pupu	PUPU/Mlb	≥ 3 yrs.	M
2009	SDR / ALT / REF	SDR / ALT / REF	0.06	-	LBBK/Mlb	≥ 2 yrs.	M
2009	SDR / MER / REF	SDR / MER / REF	0.05	-[d]	-	≥ 3 yrs.	M
2009	SDR / SGSA / REF	SDR / SGSA / REF	0.05	Mlb	BYST/pupu	≥ 3 yrs.	M
2009	SDR / SGFU / REF	SDR / SGFU / REF	0.03	PUYE/Mlb	-	≥ 3 yrs.	M
2009	SDR / SGCA / REF	SDR / SGCA / REF	0.01	BKLB/pupu	Mlb	≥ 2 yrs.	M
2009	SDR / JOY / REF	SDR / JOY / REF	0.01	Mlb	BKLB/pupu	≥ 2 yrs.	M
2009	SDR / MER / REF	SDR / POR / REF	0.27	LPLP/Mlb	-	≥ 3 yrs.	F
2009	SDR / PA10 / TMT	SDR / CL6 / TMT	1.09	WHPU/Mlb	-	2 yrs.	M
2009	SDR / CCO / TMT	SDR / CCO / TMT	0.17	LBLB/Mlb	-	≥ 2 yrs.	M
2009	SDR / SGPP / TMT	SDR / SGPP / TMT	0.12	Mlb	BKBK/pupu	≥ 3 yrs.	M
2009	SDR / FJS2 / TMT	SDR / FJS2 / TMT	0.11	-	BKLB/Mlb	≥ 2 yrs.	M
2009	SDR / HTS / TMT	SDR / HTS / TMT	0.08	-	YEPU/Mlb	≥ 3 yrs.	M
2009	SDR / WMB2 / TMT	SDR / WMB2 / TMT	0.05	DPWH/Mlb	-	≥ 3 yrs.	M
2009	SDR / SGPN / TMT	SDR / SGPN / TMT	0.04	-	PUPU/Mlb	≥ 3 yrs.	M
2009	SDR / WMBB / TMT	SDR / SGSO / TMT	0.03	-[d]	-	≥ 3 yrs.	M
2009	SDR / EDD / TMT	SDR / EDD / TMT	0.03	-	DPWH/Mlb	2 yrs.	M
2009	SDR / FRE / TMT	SDR / FRE / TMT	0.03	WHPU/pupu	Mlb	≥ 2 yrs.	M
2009	SDR / SGTS / TMT	SDR / SGTS / TMT	0.03	BKBK/Mlb	pupu	≥ 3 yrs.	M
2009	SDR / BTN / TMT	SDR / BTN / TMT	0.01	DPDP/Mlb	-	≥ 3 yrs.	M
2009	SDR / SGPP / TMT	SDR / BTN / TMT	0.05	LPBK/Mlb	-	2 yrs.	F
2009	SDR / HTS / TMT	SDR / SGCH / REF	2.73	-	WHPU/Mlb	1 yr.	F
2009	SDR / FJS2 / TMT	SDR / CCO / TMT	0.49	-	WHDP/Mlb	1 yr.	F
2009	SDR / PA11	SDR / VA03	9.29	-	PUYE/Mlb	1 yr.	M
2008	SDR / SGCA / REF	SDR / SGCA / REF	0.03	WHDP/Mlb	pupu	≥ 3 yrs.	M
2008	SDR / BTN / TMT	SDR / PA07 / TMT	0.90	PUYE/Mlb	-	2 yrs.	M
2008	SLR / DGWE	SDR / SGPN / TMT	51.51	WHWH/Mdb	LPBK	2 yrs.	F

[a] Drainage Codes: SDR = San Diego River; SLR = San Luis Rey River.
[b] Band Colors: Mdb = dark blue numbered federal band; Mlb = light blue numbered federal band; pupu = metal purple; BKBK = plastic black; BKLB = plastic black-light blue split; BYST = plastic black-yellow striped; DPDP = plastic dark pink; DPWH = plastic dark pink-white split; LBBK = plastic light blue-black split; LBLB = plastic light blue; LPBK = plastic light pink-black split; LPLP = plastic light pink; PUPU = plastic purple; PUWH = plastic purple-white split; PUYE = plastic purple-yellow split; WHDP = plastic white-dark pink split; WHPU = plastic white-purple split; WHWH = plastic white; YEPU = plastic yellow-purple split; YEYE = plastic yellow.
[c] Sex: M = male; F = female.
[d] These vireos were banded when first seen but bands were removed because of leg injuries.

Incidental Detections

On 10 June, during a vireo survey, we detected a single, banded Southwestern Willow Flycatcher (*Empidonax traillii extimus*) in the Valley survey area (Fig. 12). The flycatcher was unpaired and remained in the area until 30 June. This bird was recaptured on 30 June and given a full color band combination. It was originally banded as a nestling on Marine Corps Base Camp Pendleton in 2009 (Howell and Kus 2009), approximately 61.7 km to the north.

Nest Monitoring

A total of 26 territories were monitored for nesting activity within the Treatment and Reference monitoring sites (Table 10; Figs. 3 and 4; Appendix C). All of territories were "fully" monitored, meaning that all nests within the territory were found and documented during the breeding season. At three fully monitored territories in the Reference monitoring site, the males remained single throughout the 2010 breeding season and therefore no nests were completed in these three territories. These territories were excluded from nest monitoring analyses. A total of 59 nests were monitored during the breeding season; however, 3 of these were not completed (coded as "INC" of "FAL" in Appendix C) and have been excluded from calculations of nest success and productivity.

Table 10. Number of Least Bell's Vireo territories and nests monitored at Treatment and Reference sites on the San Diego River, 2010. Averages presented as mean ± standard deviation.

	Nest Monitoring Site/Type		
	Treatment	**Reference**	**Total**
Territories fully monitored	13	13[a]	26
Nests in monitored territories[b]	30	29	59
Completed nests per pair	2.2 ± 0.9	2.8 ± 1.2	2.4 ± 1.1

[a] Includes three territories with single males.
[b] Includes incomplete nests (two at the Treatment site and one at the Reference site).

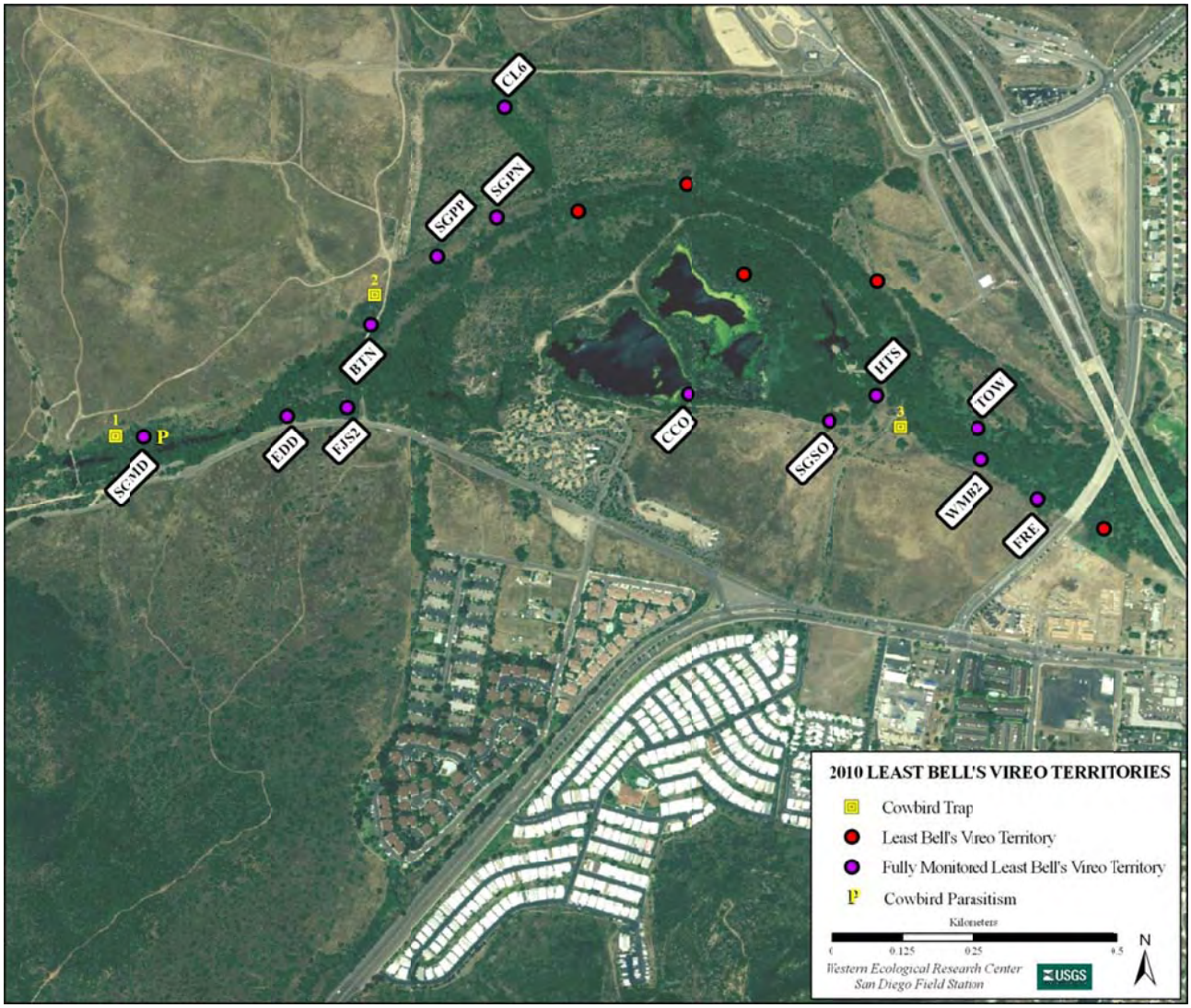

Fig. 3. Locations of monitored Least Bell's Vireo territories at the Park Brown-headed Cowbird (*Molothrus ater*) removal (Treatment) site, San Diego River, 2010.

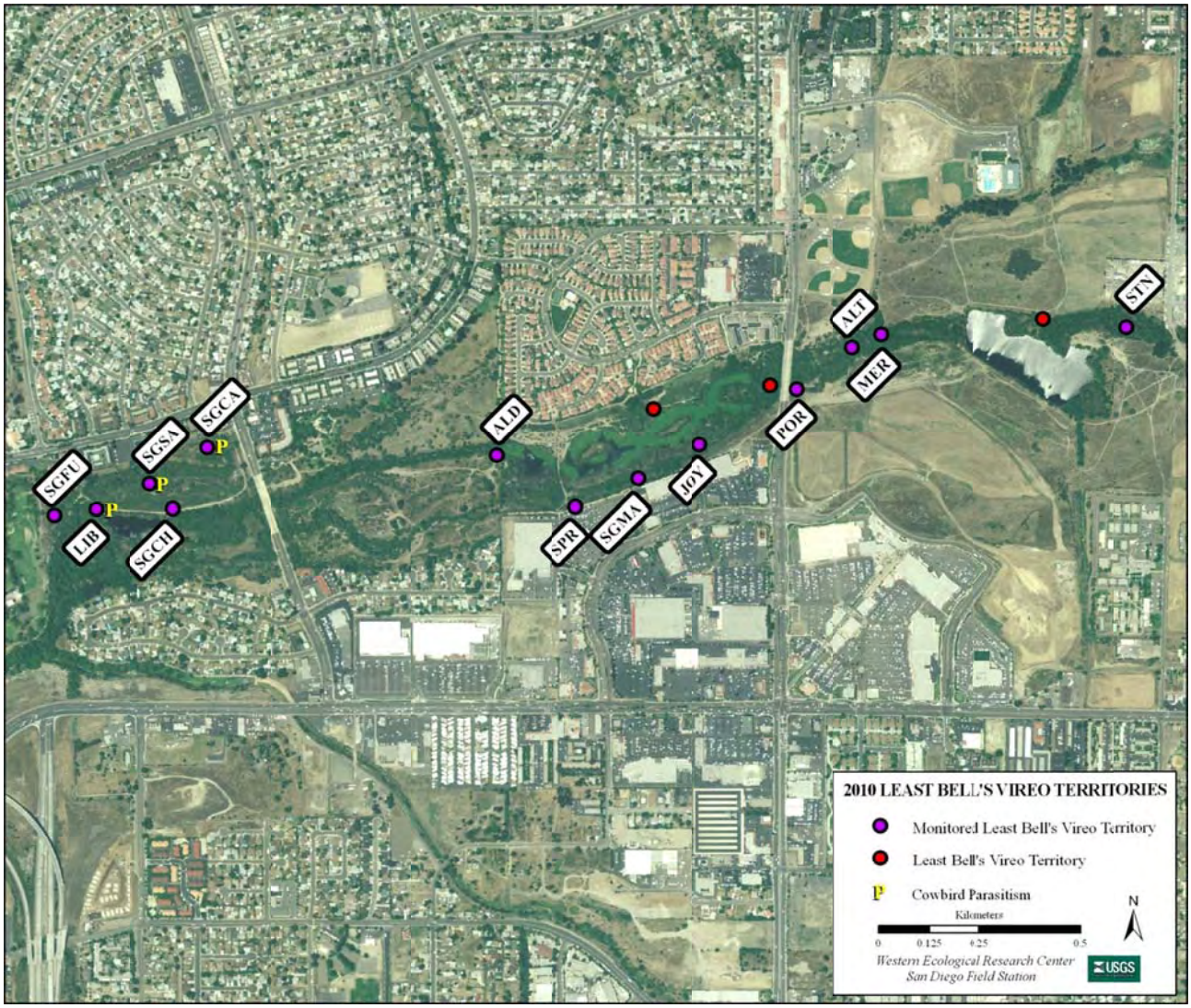

Fig. 4. Locations of monitored Least Bell's Vireo territories at the Santee Reference site, San Diego River, 2010.

Nest Initiation

Nesting activity started in mid-April and continued until mid-July (Fig. 5). Excluding the three territories with single males, 83% (19/23) of the pairs had attempted nesting by the end of April, and 96% (22/23) by the end of May. One pair did not initiate nesting until June.

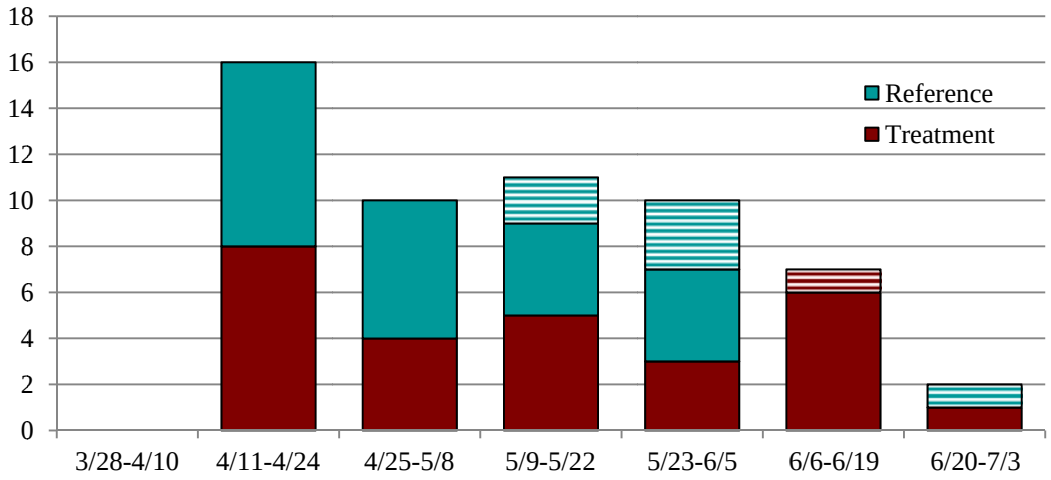

Fig. 5. Number of Least Bell's Vireo nests and those that were parasitized by Brown-headed Cowbirds by two-week intervals, San Diego River, 2010. Parasitized nests represented by horizontal hatching.

Every fully monitored pair initiated at least one nest in 2010. Of paired males, 19 (83%) re-nested after first attempts. Three pairs (16%) re-nested after a successful first nest, and 16 pairs (84%) initiated a second nest after a failed first attempt. Five pairs that re-nested after a first attempt (26%) had successful second nests (all after failed first attempts). Eleven pairs (58%) initiated a third nesting attempt, two of which were successful. Five pairs attempted a fourth nest, two of which were successful, and one pair attempted to nest five times, successfully fledging young on their fifth attempt. One pair successfully fledged two broods in 2010. Pairs at the Treatment site completed the same number of nests as pairs at the Reference site (Table 10; $t = -1.46$, $P = 0.16$).

Cowbird Parasitism

A total of 32 cowbirds were captured and removed from the Treatment site in 2010, (18 males and 14 females; Sexton 2010; Fig. 3). No juvenile cowbirds were captured in 2010.

Thirteen percent (7/56 completed nests) of vireo nests were parasitized by cowbirds in 2010, although one of these (at the Treatment site) was not parasitized until after the nest had failed. A marginally lower proportion of nests were parasitized at the Treatment site (4%; 1/28) compared to the Reference site (21%; 6/28; Fisher's Exact $P = 0.10$; Fig. 6). There was no significant change in rate of cowbird parasitism between 2009 and 2010 at the Treatment site (2009 = 15%; Fisher's Exact $P = 0.21$) although there was a marginal decrease in parasitism at the Reference site (2009 = 45%; Fisher's Exact $P = 0.12$). However, parasitism at both sites has decreased significantly since 2008 (Treatment site 2008 = 38%, Fisher's Exact $P < 0.01$; Reference site 2008 = 61%, Fisher's Exact $P = 0.01$). Both sites have shown a consistent decrease in parasitism since 2008, and the decreases at the two sites are highly correlated (Pearson's $R = 0.95$; Fig. 6). The only parasitism at the Treatment site was observed in a nest initiated during the third week of June (21 June), approximately 3 weeks after cowbird traps were closed (31 May). Parasitism was first observed at the Reference site in a nest initiated during the second week of May (11 May) after which parasitism rate remained consistently high

(range of 50-100%, average 75%) for nests initiated per two-week interval for the remainder of the breeding season (Fig. 5).

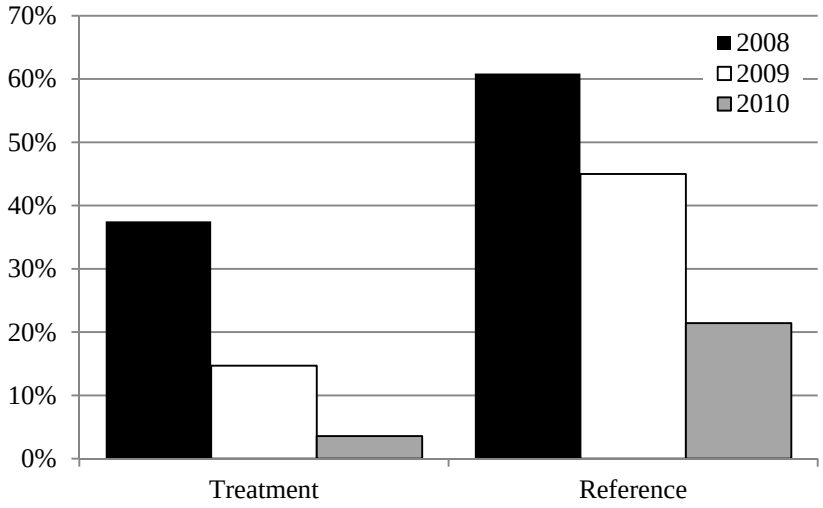

Figure 6. Percent of Least Bell's Vireo nests that were parasitized by Brown-headed Cowbirds at Treatment and Reference sites, 2008-2010, San Diego River, CA.

Three of the seven parasitized nests (all in the Reference sites) were parasitized more than once (two nests contained two cowbird eggs and a third contained three cowbird eggs) in 2010 (43%), an increase over 2009 (7%) and 2008 (16%). No monitored nests contained cowbird nestlings or fledged cowbird young. Six cowbird eggs were removed from nests found during monitoring and surveying. Five other cowbird eggs were not removed because the nest failed before removal could occur.

Parasitism was responsible for the failure of 5% (3/56) of completed nests; however, not all instances of parasitism resulted in nest failure (Table 11). Fifty-seven percent of the parasitized nests (Treatment 100%, Reference 50%) remained active following the removal of cowbird eggs or were parasitized after the nest had already failed. While some of these nests failed later, those that were successful were responsible for the production of 13% (5/40) of all young fledged along the river.

Fate of Nests

Twenty-five percent of the completed nests along the San Diego River were successful, producing at least one vireo fledgling (Table 12). Two of these successful nests fledged young after manipulation to remove cowbird eggs. In the absence of manipulation, the success rate of completed nests along the San Diego River in 2010 would have been reduced by 4%. Nest success did not differ significantly by site (Fisher's Exact $P = 0.12$). Counting all parasitized nests as failed, nest success would have been significantly lower at Reference sites than at Treatment sites (Fisher's Exact $P = 0.04$).

Table 11. Number and fate of Least Bell's Vireo nests parasitized by Brown-headed Cowbirds in fully monitored territories, San Diego River, 2010.

	Treatment	Reference	Total
Nests Parasitized	1	6	7
Pairs Parasitized	1	3	4
Total Cowbird Eggs Laid	1	10	11
Fate of Nests:			
Abandoned	NA	3	3
Not abandoned			
Successful	NA	2	2
Unsuccessful	1[a]	1	2

[a] Nest was parasitized after failure.

Table 12. Fate of Least Bell's Vireo nests in fully monitored territories, San Diego River, 2010. Numbers in parentheses are percent of total nests.

	Number of Nests		
Nest Fate	**Treatment**	**Reference**	**Total**
Successful	10 (36%)	4 (14%)	14 (25%)
Failed			
Predation	17 (61%)	12 (43%)	29 (52%)
Parasitism	0 (0%)	3 (11%)	3 (5%)
Other/Unknown	1 (4%)	9 (32%)	10 (18%)
Total Completed Nests	28	28	56

Seventy-five percent of nests observed were unsuccessful in fledging vireo young (Table 12). Nest failure throughout the monitoring sites was primarily attributed to predation, although predation events were not observed. Predation was determined based upon circumstantial evidence such as the loss of eggs and/or young from intact nests, partial or complete destruction of nests, and the presence of eggshell fragments in or beneath abandoned nests. American Crows (*Corvus brachyrhynchos*) and Cooper's Hawks (*Accipiter cooperii*) were active in two territories where multiple nests failed as a result of predation. Other potential predators include snakes (Clark 2009), birds such as Western Scrub-jays (*Aphelocoma californica*), small mammals, Virginia opossums (*Didelphis virginiana*), Argentine ants (*Linepithema humile*; Peterson *et al*. 2004), and alligator lizards (*Elgaria multicarinata*; D. Evans unpubl. data).

Nest failures were not limited to predation and parasitism. At the Reference site, a nest failed after the supporting cottonwood branch collapsed. Three nests at the Reference site were abandoned with vireo eggs for unknown reasons. No eggs were seen in three nests at the Reference site and one nest at the Treatment site which may have been depredated or abandoned between nest-building and egg-laying. Finally, two nests at the Reference site were knocked down with no sign of predation and may have been destroyed by humans.

Productivity

Reproductive indices for vireos were similar between the Treatment and Reference nest monitoring sites. Average clutch size was relatively high and did not differ between sites for non-parasitized nests ($t = 0.10$, $P = 0.92$). Hatching success was similar between sites and averaged 55% for vireo eggs and 54% for nests. We documented at least 40 fledglings in 2010, most of which (78%) came from nests in the Treatment site. The total number of fledglings in 2010 would be reduced by five if parasitized nests had been allowed to fail. One pair at the Treatment site successfully double-brooded, fledging young from two nests. The number of fledglings per pair was significantly higher at the Treatment site than at the Reference site (Table 13). The number of young fledged per pair was significantly higher at the Treatment site than at the Reference site when we assumed nests that had been parasitized would have failed.

Table 13. Reproductive success and productivity of nesting Least Bell's Vireos, San Diego River, 2010. Averages presented as mean ± standard deviation.

	Total Number		
Parameter	**Treatment**	**Reference**	**Total**
Nests with eggs	27	23	50
Eggs laid	89	61	150
Average clutch size			
Non-Parasitized[a]	3.5 ± 0.7	3.4 ± 0.5	3.5 ± 0.6
Parasitized[b]	4	2.0 ± 0.7	2.3 ± 1.0
Nests with hatchlings	15	12	27
Hatchlings	47	36	83
Hatching success:			
Eggs[c]	53%	59%	55%
Nests[d]	56%	52%	54%
Nests with fledglings	10 (10)[e]	4 (2)[e]	14 (12)[e]
Fledglings	31 (31)[e]	9 (4)[e]	40 (35)[e]
Fledging success:			
Hatchlings[f]	66% (66%)[e]	25% (11%)[e]	48% (42%)[e]
Nests[g]	67% (67%)[e]	33% (17%)[e]	52% (44%)[e]
Fledglings per egg	0.3 (0.3)[e]	0.1 (0.1)[e]	0.3 (0.2)[e]
Fledglings per nest	1.1 (1.1)[e]	0.4 (0.2)[e]	0.8 (0.7)[e]
Average number of young fledged per pair[h]	2.4 ± 2.3 (2.4 ± 2.3)[e]	0.9 ± 1.3 (0.4 ± 0.9)[e]	1.7 ± 2.0 (1.5 ± 2.1)[e]
Pairs fledging ≥ 1 young	9 / 69% (9 / 69%)[e]	4 / 40% (2 / 20%)[e]	13 / 57% (11 / 48%)[e]

[a] Based on 23 Treatment and 10 Reference non-parasitized nests with a full clutch.
[b] Based on one Treatment and five Reference parasitized nests. No vireo eggs were observed in the sixth Reference parasitized nest so this nest was not included in the calculation.
[c] Percent of all eggs that hatched.
[d] Percent of all nests with eggs in which at least one egg hatched.
[e] Number in parentheses is result if parasitized nests had not been manipulated but had been allowed to fail.
[f] Percent of all nestlings that fledged.
[g] Percent of all nests with nestlings in which at least one young fledged.
[h] Based on 13 Treatment and 10 Reference pairs. Mann-Whitney $U = 38.0$, $P = 0.08$. If parasitized nests were allowed to fail, Mann-Whitney $U = 28.5.0$, $P = 0.01$.

Nest Characteristics

In 2010, successful and unsuccessful nests within monitoring sites had similar nest placement characteristics. However, at the Reference site, successful nests were placed significantly further from the edge of the riparian vegetation than unsuccessful nests (Table 14;

this difference was no longer significant when parasitized nests were considered to be unsuccessful). We found no difference in nest placement between the Treatment and Reference sites (Table 15).

Table 14. Least Bell's Vireo nest characteristics and results of Mann-Whitney *U*-tests of successful vs. unsuccessful nesting attempts at nest monitoring sites along the San Diego River, 2010. Numbers in parentheses represent recalculated figures that consider all parasitized nests to be unsuccessful.

	Nest Fate				
Nest Characteristic	**Successful**	**Unsuccessful**	***n*[a]**	***U*[b]**	***P*[c]**
Treatment Site					
Average nest height (m)	0.77	1.04	10, 17	60.0	0.21
Average host height (m)	2.76	3.33	10, 19	71.0	0.27
Average distance to edge of host (m)	0.66	0.47	10, 19	117.0	0.31
Average distance to edge of clump (m)	1.81	1.83	10, 19	106.0	0.61
Average distance to edge of riparian vegetation (m)	16.95	18.74	10, 19	84.5	0.63
Reference Site					
Average nest height (m)	1.01 (1.22)	0.96 (0.95)	4, 24 (2, 26)	57.5 (44.0)	0.53 (0.11)
Average host height (m)	4.35 (5.25)	4.41 (4.34)	4, 25 (2, 27)	55.5 (34.5)	0.73 (0.52)
Average distance to edge of host (m)	0.40 (0.40)	0.59 (0.40)	4, 25 (2, 27)	52.5 (38.5)	0.87 (0.32)
Average distance to edge of clump (m)	1.01 (1.42)	1.25 (1.20)	4, 25 (2, 27)	53.0 (34.0)	0.85 (0.55)
Average distance to edge of riparian vegetation (m)	22.00 (29.00)	8.78 (9.24)	4, 25 (2, 27)	78.5 (40.5)	**0.07** (0.24)

[a] *n* = number of nests in sample (Successful, Unsuccessful).
[b] *U* = Mann-Whitney *U* statistic.
[c] *P* = P-value.

Table 15. Least Bell's Vireo nest characteristics and results of Mann-Whitney *U*-tests between monitoring sites along the San Diego River, 2010.

Nest Placement Characteristic	**Treatment**	**Reference**	***U*[a]**	***P*[b]**
Average nest height (m)	0.94	0.97	232.0	0.29
Average host height (m)	3.13	4.40	257.0	0.35
Average distance to edge of host (m)	0.53	0.40	368.5	0.27
Average distance to edge of clump (m)	1.82	1.21	346.0	0.49
Average distance to edge of riparian vegetation (m)	18.12	9.63	362.5	0.32

[a] *U* = Mann-Whitney *U* statistic.
[b] *P* = P-value.

A total of 14 plant species were used as hosts for vireo nests at monitoring sites in 2010, although not all were used within each site (Table 16). Vireos used 11 of the 14 at the Treatment site and 8 of the 14 species at the Reference site. Host species selection differed between sites, with only five species used at both sites. At the Treatment site, 52% of vireo nests were placed in willows and mule fat while 75% of the vireo nests at the Reference site were placed in willows and mule fat. Seven vireo nests at the Treatment site were built in exotic plant species (three in giant reed, three in black mustard, and one in thistle; *Cirsium* sp.) and all but one of these nests

was unsuccessful (one nest in black mustard successfully fledged young). No vireo nests at the Reference site were built in exotic host species.

Table 16. Host plant species used by Least Bell's Vireos at monitoring sites along the San Diego River, 2010. Numbers in parentheses are proportions of total nests at that site.

	Number of Nests	
Host Species	**Treatment**	**Reference**
Mule fat	6 (0.21)	7 (0.24)
Arroyo or red willow	6 (0.21)	5 (0.17)
Black willow	3 (0.10)	3 (0.10)
Giant reed	3 (0.10)	
Black mustard	3 (0.10)	
Mugwort (*Artemisia douglasiana*)	2 (0.07)	1 (0.03)
Poison oak (*Toxicodendron diversilobum*)	2 (0.07)	
Coast live oak (*Quercus agrifolia*)	1 (0.03)	2 (0.07)
California wild rose (*Rosa californica*)	1 (0.03)	
Thistle	1 (0.03)	
Toyon (*Heteromeles arbutifolia*)	1 (0.03)	
Sandbar willow		7 (0.24)
Freemont cottonwood		3 (0.10)
Wild grape (*Vitis* sp.)		1 (0.03)

DISCUSSION

Surveys for Least Bell's Vireos have been conducted along the San Diego River periodically since the mid-1970s. Vireos have been documented within the same general area (Mission Dam to Santee) over a number of years and increased from 11 territories in 1978 to a high of 36 territorial males in 1994 (Goldwasser 1978; Jones 1985; Kus 1989, 1992, 1994, 1995; Kus and Beck 1998; Wellik *et al.* 2009; USGS unpubl. data; Fig. 7). In 2008, this number dropped to its lowest point since 1978, then almost doubled in 2009, and then dropped again by 13% in 2010.

Surveys of other areas on the river have been conducted less frequently, but show a more promising increase in vireo territories from 1978 through 2010 (Table 17; SANDAG 1990, Kus and Beck 1998). In 2010, the bulk of vireo territories remained in the central section of the river, in the Park and Santee survey sections. However, the number of vireo territories detected in the Gorge and Lakeside survey sections (flanking Park and Santee) has steadily increased and approached the numbers found in the Park and Santee sections in 2010. This shift in territory distribution suggests that the vireo population may be expanding outside of the ideal "core" habitat to occupy less suitable areas or that conditions are improving outside of the central section of the river drainage. Vireo numbers continued to fluctuate in the lowest and upper-most sections of the river (Valley and El Capitan) since 1997.

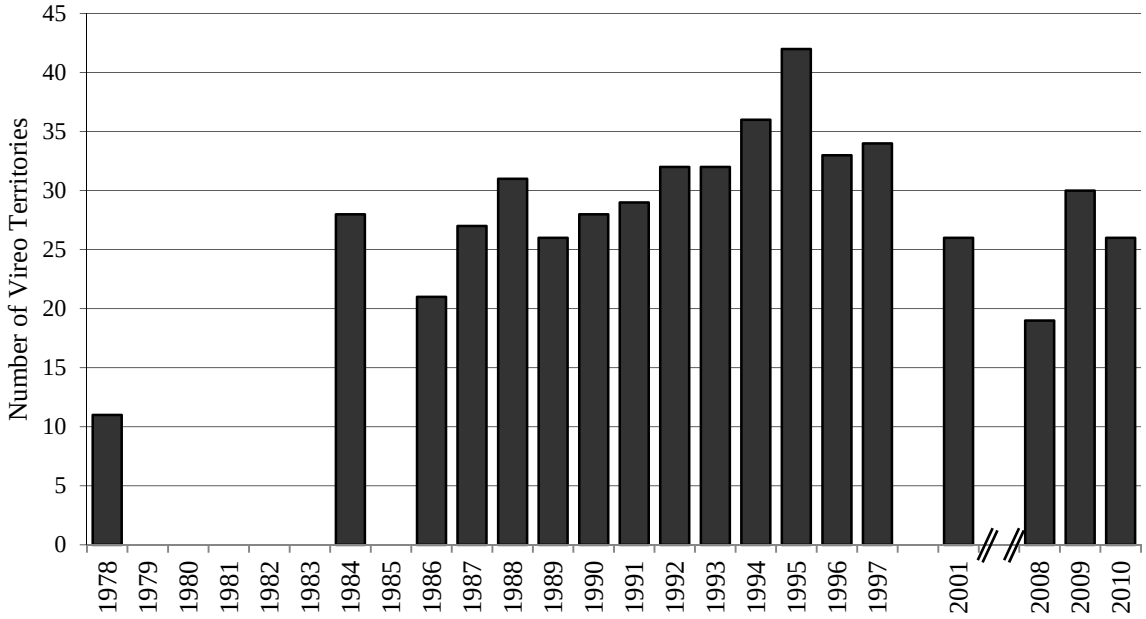

Fig. 7. Number of Least Bell's Vireo territories between Mission Dam and Santee, San Diego River, 1978-2010.

Table 17. Number of Least Bell's Vireo territories occurring historically along the San Diego River. (Sources: SANDAG 1990, Kus and Beck 1998).

	Number of Territorial Males					
Survey Site	**1978**	**1987**	**1997**	**2008**	**2009**	**2010**
Valley	1	0	7	1	3	6
Gorge	-	2	7	13	12	20
Park	8	12	19	18	23	21
Santee	3	12	24	20	30	26
Lakeside	-	5	3	11	14	16
El Capitan	-	-	2	0	0	1
Total	12	31	60	63	82	90

The number of vireo territories along the San Diego River follows the general trend in southern California, where the vireo population increased dramatically since the mid-1980s (Lynn and Kus 2010, Ferree et al. 2010). However, whereas vireo numbers increased 6-7-fold between 1987 and 1997 on Marine Corps Base Camp Pendleton (Lynn and Kus 2010), and doubled between 1997 and 2008 on the lower San Luis Rey River (Ferree et al. 2010), vireo numbers on the San Diego River increased more slowly during that time period.

The swamping of suitable vireo habitat by exotic giant reed has been identified as a management issue for vireos in many riparian areas in southern California. Marine Corps Base

Camp Pendleton has been removing giant reed from the Santa Margarita River (the most extensive habitat for Least Bell's Vireo on Base) since 1996, and the lower San Luis Rey River is also being managed to control giant reed and protect Least Bell's Vireo habitat. Such programs have been sporadic and widely spaced along the San Diego River. Large stands of giant reed were observed in sections of the river in 2008 and 2009, and removal had begun in the eastern extent of the Valley survey section in late 2008/early 2009. In 2010, we detected a pair of vireos using the periphery of this clearing (Appendix B, Fig. 13). We also detected a single Southwestern Willow Flycatcher within this area using dead stalks of giant reed as foraging perches. Removal of giant reed also occurred along the Carlton Oaks Golf Course as of November 2009 although no new vireo territories were detected in this section in 2010. Giant reed was mostly dead in both of these removal areas, although some new sprouting was observed. In subsequent years of this study, vireos should respond as the management actions that have been planned are implemented along other sections of the San Diego River.

As expected, vireos occupied territories in mixed willow and mixed willow/cottonwood riparian vegetation. We did not define vegetation in areas the vireos did not occupy to quantify the extent of exotic vegetation throughout the drainage; however, vireos may be avoiding these areas because only two vireo territories were placed in non-native vegetation. The Valley survey section continued to contain extensive patches of giant reed which were not occupied in 2008, 2009, or 2010, although new vireo territories were established in more suitable habitat in 2010.

Banding of Least Bell's Vireos allows us to estimate both adult and juvenile survival rates as well as investigate annual dispersal of adult and first-year adult vireos. Thirty-six banded vireos were resighted along the San Diego River in 2010. Two of these vireos had dispersed from their natal drainages (the San Luis Rey River) to the San Diego River, demonstrating the potential for vireos to move far beyond their natal drainages. Vireos in other years have moved from the San Diego River to Marine Corps Base Camp Pendleton (Lynn and Kus 2010, Lynn *et al*. 2010), in further support of the vireos' ability to move between drainages. On the other hand, many of the adult vireos that returned to the San Diego River in 2010 occupied the same territories that they had in 2009, demonstrating strong breeding site fidelity. Further banding and resighting of vireos within southern California will allow a better determination of the extent of movement between populations and the role such movements play in maintaining genetic diversity and persistence in these populations. Continued monitoring of cohorts banded as nestlings provides the opportunity to collect life-time reproductive data for a segment of the population, facilitating identification of age-and possibly sex-related patterns in life history characteristics that influence population size, productivity, and genetic structure.

In 2010, we detected a single Southwestern Willow Flycatcher on the San Diego River. This bird remained in the same area for approximately three weeks, although it was not paired. In 2009, a different single flycatcher was detected on the San Diego River, approximately 5 km downstream of the 2010 flycatcher. The movement of both of these birds from Marine Corps Base Camp Pendleton demonstrates the ability of this species to colonize new areas, and further suggests that areas on the San Diego River contain suitable habitat to attract this species. No formal Southwestern Willow Flycatcher surveys were conducted on the San Diego River during 2010, so it is possible that other individuals were present but undetected. Three pairs of Southwestern Willow Flycatchers were detected on the San Diego River in 2001, two above El

Capitan Reservoir (Kus *et al*. 2003) and one at William Heise County Park near Julian, California (J. Barth, unpubl. data). While these records are well upstream of the flycatchers that we found in 2009 and 2010, the San Diego River was identified as a potential drainage for establishing a flycatcher population (part of the Coastal California Recovery Unit) in the Southwestern Willow Flycatcher final recovery plan (USFWS 2002). Future surveys and observations should determine whether or not the recent detections represents the re-establishment (or new establishment) of a population of this species on the San Diego River.

Cowbird trapping has been shown to decrease incidence of cowbird nest parasitism for vireos. At Marine Corps Base Camp Pendleton and the lower San Luis Rey River, intensive programs to control Brown-headed Cowbirds have dramatically reduced cowbird parasitism of Least Bell's Vireo nests, although a delay in opening cowbird traps along the lower San Luis Rey led to a substantial increase in cowbird parasitism (2% to 17% of nests from 2008 to 2009; Ferree and Kus 2008, Ferree et al. 2010). In 2010, cowbird traps on the San Diego River were opened at the beginning of April and closed at the end of May to determine whether this reduced trapping period could still effectively control cowbird parasitism in the Treatment site. During the period that traps were open, no cowbird parasitism occurred in the Treatment site. Only one nest was parasitized in the Treatment site, at least three weeks after the traps were closed, and that nest was parasitized after it had already failed from predation. Parasitism at the Reference site occurred in nests that were initiated between 10 May and 23 June, and two parasitism events occurred in nests that were initiated after the cowbird trapping period. Cowbird parasitism has consistently been less prevalent at the Treatment site compared to the Reference site, even in 2008 when cowbird trapping did not occur (Fig. 6). We have also observed a decrease in cowbird parasitism at both sites over the past three years, including the Reference site where no cowbird trapping occurred. Therefore, we cannot conclude that the current cowbird trapping effort has had a significant effect on cowbird parasitism rates, although it is possible that cowbird trapping at the Treatment sites had a sphere of influence wide enough to incorporate the Reference site (i.e., trapping at the Treatment site had reduced the cowbird population within a wider area than just the Treatment site) or that cowbird trapping in the Treatment site prior to 2008 had a lingering influence over the Treatment site. The lower cowbird parasitism rate at the Treatment site may partially account for the higher breeding productivity of vireos there, which produced 31 fledglings while the Reference site produced 9 fledglings in 2010.

Because not all parasitized nests failed, the removal of cowbird eggs from parasitized nests potentially helped increase nest success (21% to 25%). However, it cannot prevent reduced productivity associated with parasitism relative to areas with no cowbird parasitism because removing cowbird eggs does not replace the vireo eggs that were removed by cowbirds.

Cowbirds have been trapped almost annually along the San Diego River, specifically in the Park site, since as early as 1984. Cowbird trapping and vireo nest monitoring occurred simultaneously from 1987 through 1996, during which time nest parasitism rates significantly declined (Kus and Whitfield 2005). Kus and Whitfield (2005) also found that decreasing cowbird parasitism rates were associated with increasing vireo productivity, leading to an increasing trend in the vireo population ($r = 0.80$; $P < 0.01$; Fig. 7). While cowbird trapping occurred in the Park site from 2001–2007 (Varanus Biological Services 2001, 2003; Varanus

Monitoring Services 2004, 2007), vireo monitoring did not occur simultaneous with this later cowbird trapping effort.

Cowbird parasitism resulted in the loss of 5% of nests in 2010, although if no parasitized nests had been rescued (by the removal of cowbird eggs), the rate of nest loss would have risen to 9%. However, 52% of nests failed from predation, indicating that predation, possibly exacerbated by habitat conditions, should not be discounted as a risk to vireo nests, and may be more of a concern than previously thought.

In 2010, pairs at the Treatment site fledged more than twice as many young per pair than did pairs at the Reference site. This follows the same trend as the past two years, when the Treatment site had higher nest success and more young fledged per pair. Because most nest site characteristics did not differ between Treatment and Reference site, or between successful and unsuccessful nests either at Reference sites or at Treatment sites, it is evident that habitat characteristics alone were not responsible for differences in vireo breeding success and productivity. Similarly, Kus *et al*. (2008) found that fine-scale and intermediate-scale nest placement factors were not significantly related to nest survival along the San Luis Rey River.

CONCLUSIONS AND FUTURE DIRECTIONS

One of the management options for protecting and enhancing the San Diego River vireo population is cowbird control. Our project was designed to allow an experimental determination of the most cost- and biologically-effective way to achieve that control. Historically, cowbird control has been initiated with the goal of eliminating parasitism of vireo nests within a prescribed area through the annual operation of multiple traps "in perpetuity". The purpose of our project is to evaluate alternatives to this approach and to tailor a cowbird management plan specific to the San Diego River and the goals for its vireo population.

Systematic cowbird trapping is intended to provide data on the abundance and spatial and temporal distribution of cowbirds in this site. Concurrent vireo monitoring provides data on rates of parasitism, seasonal timing of parasitism, nest success, seasonal productivity (production of vireo young), dispersal, and recruitment of young vireos. With sufficient sample size over multiple years, we will be able to examine the spatial distribution of parasitized nests to determine the zone of influence of the cowbird traps and use this information to direct future trapping activities regarding trap numbers and spacing. Parasitism of vireo nests was high during the baseline study year in the absence of cowbird trapping. During the past three years of monitoring, vireo nest parasitism has declined at both the Treatment and Reference sites at similar rates despite cowbird trapping at the Treatment site, suggesting that there was a natural decline in the cowbird population across both sites. Cowbird parasitism has consistently been less frequent at Treatment sites even before trapping began, indicating that there were other differences between the sites that may be masking the effect of current cowbird trapping. Additional years of data, especially if the cowbird population were to rebound, will allow us to tease out the effect of cowbird trapping at the Treatment site relative to the Reference site.

Future aspects of the study will include adjusting the number and placement of cowbird traps based on spatial analysis of cowbird parasitism and cowbird abundance in prior years and

skipping a year of cowbird trapping while continuing to monitor vireos to determine whether vireo population goals can be maintained with trapping every other year. Ultimately, the results of this study will be useful in expanding cowbird trapping to a larger study area to identify areas that warrant cowbird control and determine the number, location, and period of operation of cowbird traps to achieve objectives of cowbird control relative to management goals of protecting and enhancing the San Diego River vireo population.

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Wellik, M. J., S. Lynn, and B. E. Kus. 2009. Distribution, abundance, and breeding activities of the Least Bell's Vireo along the San Diego River, California. 2008 Annual Data Summary. Prepared for the San Diego River Conservancy, San Diego, California.

APPENDIX A

LEAST BELL'S VIREO SURVEY AREAS ALONG THE SAN DIEGO RIVER, 2010

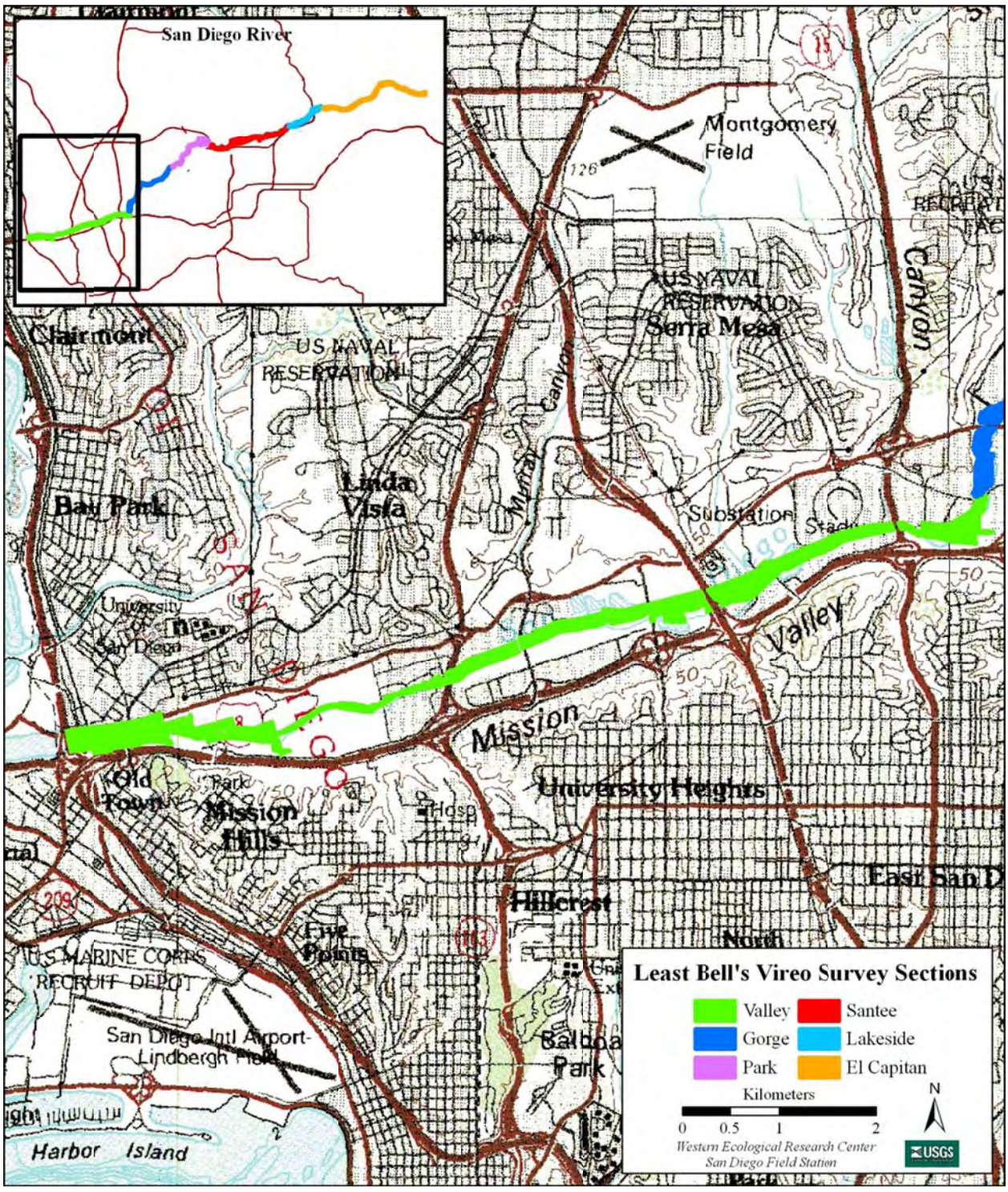

Fig. 8. Least Bell's Vireo survey areas along the San Diego River, 2010: Valley.

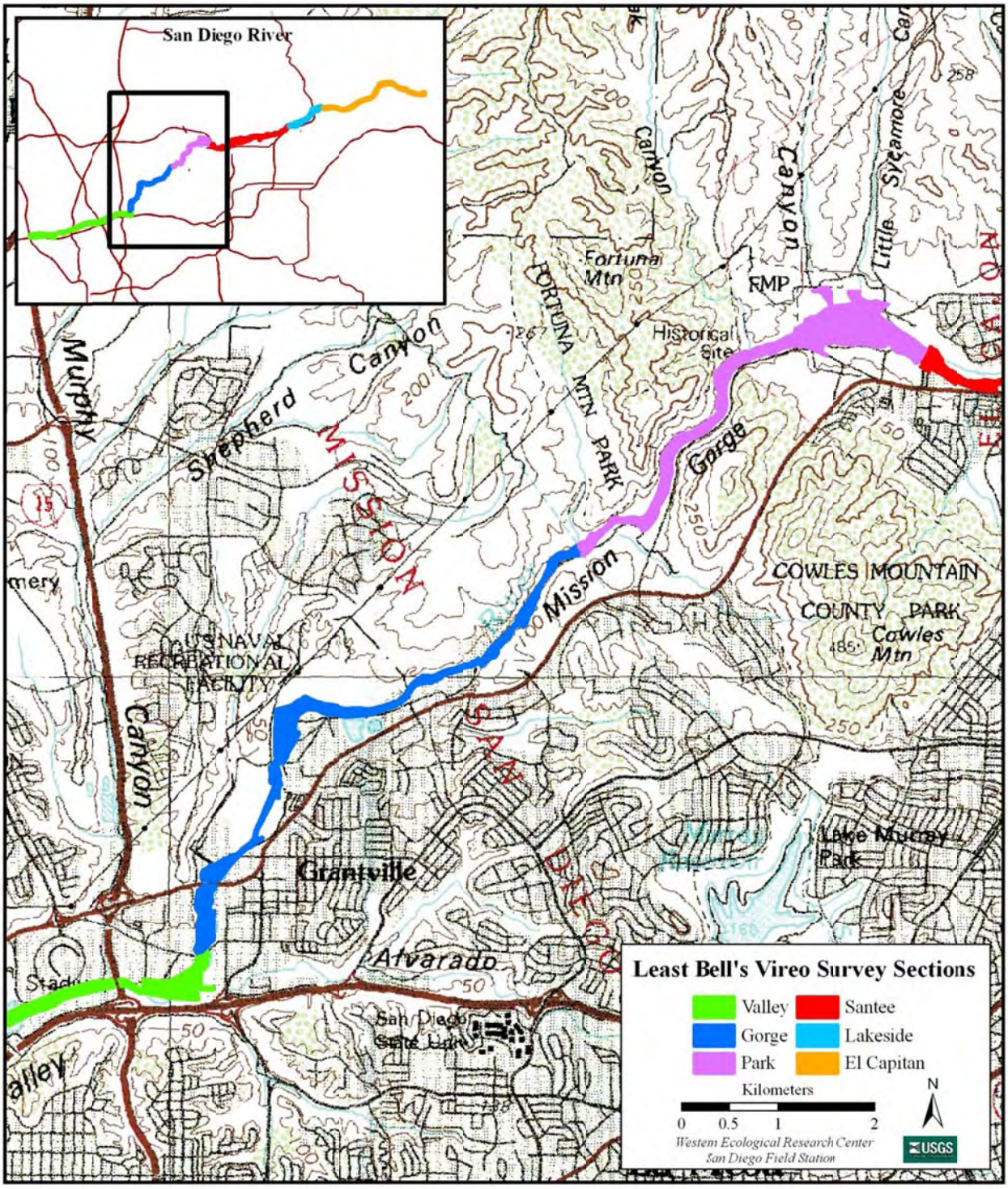

Fig. 9. Least Bell's Vireo survey areas along the San Diego River, 2010: Gorge and Park.

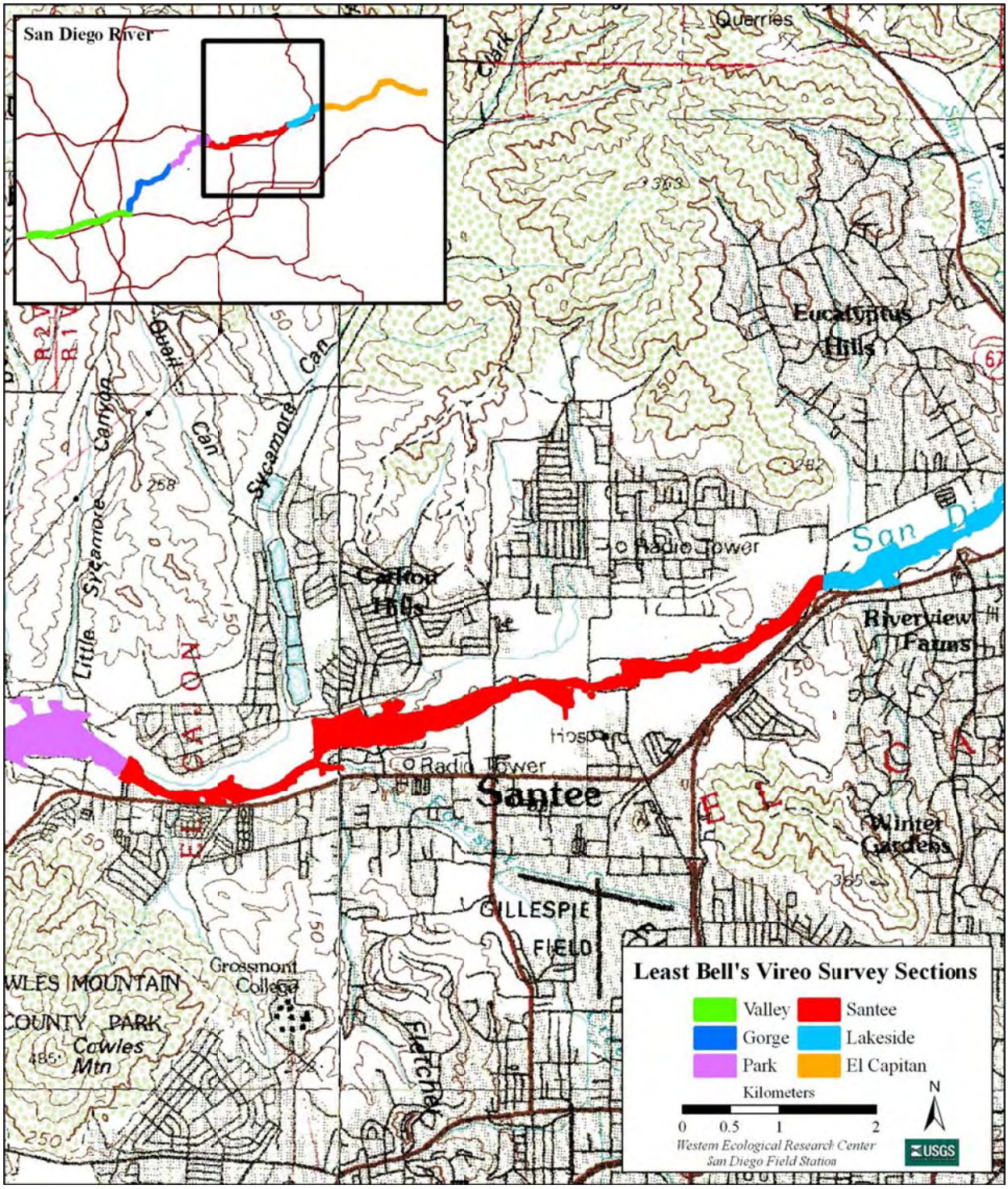

Fig. 10. Least Bell's Vireo survey areas along the San Diego River, 2010: Santee.

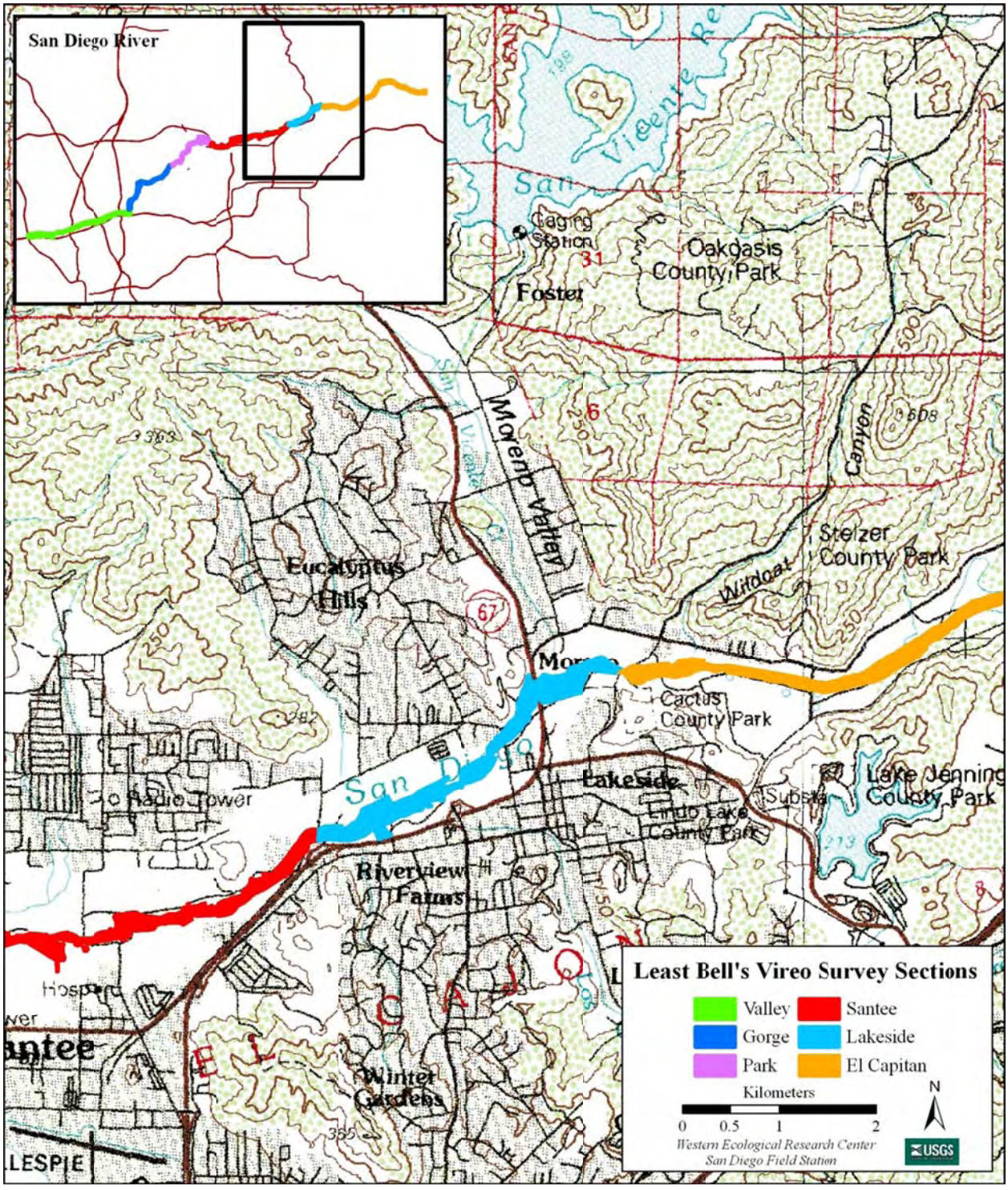

Fig. 11. Least Bell's Vireo survey areas along the San Diego River, 2010: Lakeside.

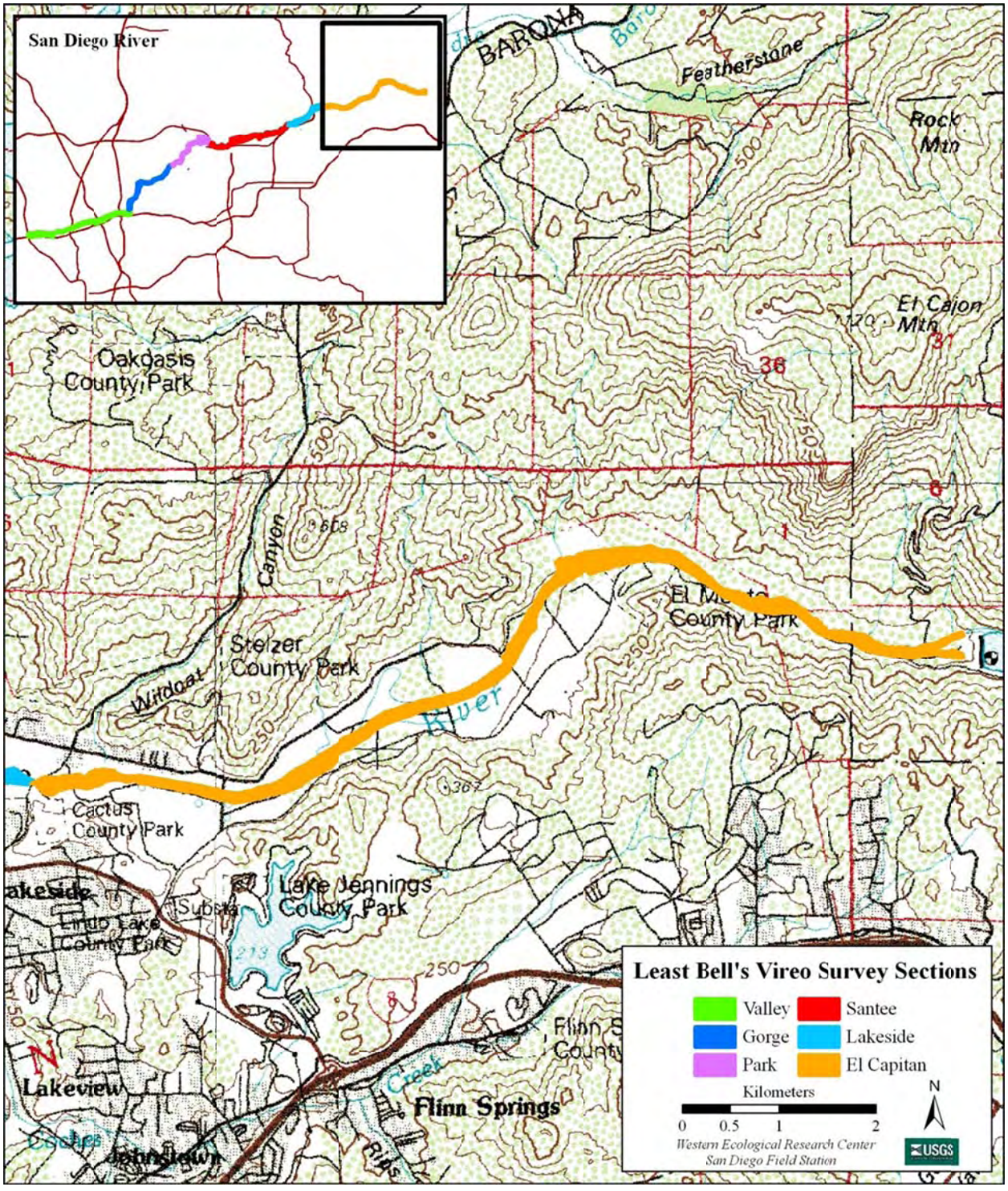

Fig. 12. Least Bell's Vireo survey areas along the San Diego River, 2010: El Capitan.

APPENDIX B

LOCATIONS OF LEAST BELL'S VIREOS ALONG THE SAN DIEGO RIVER, 2010

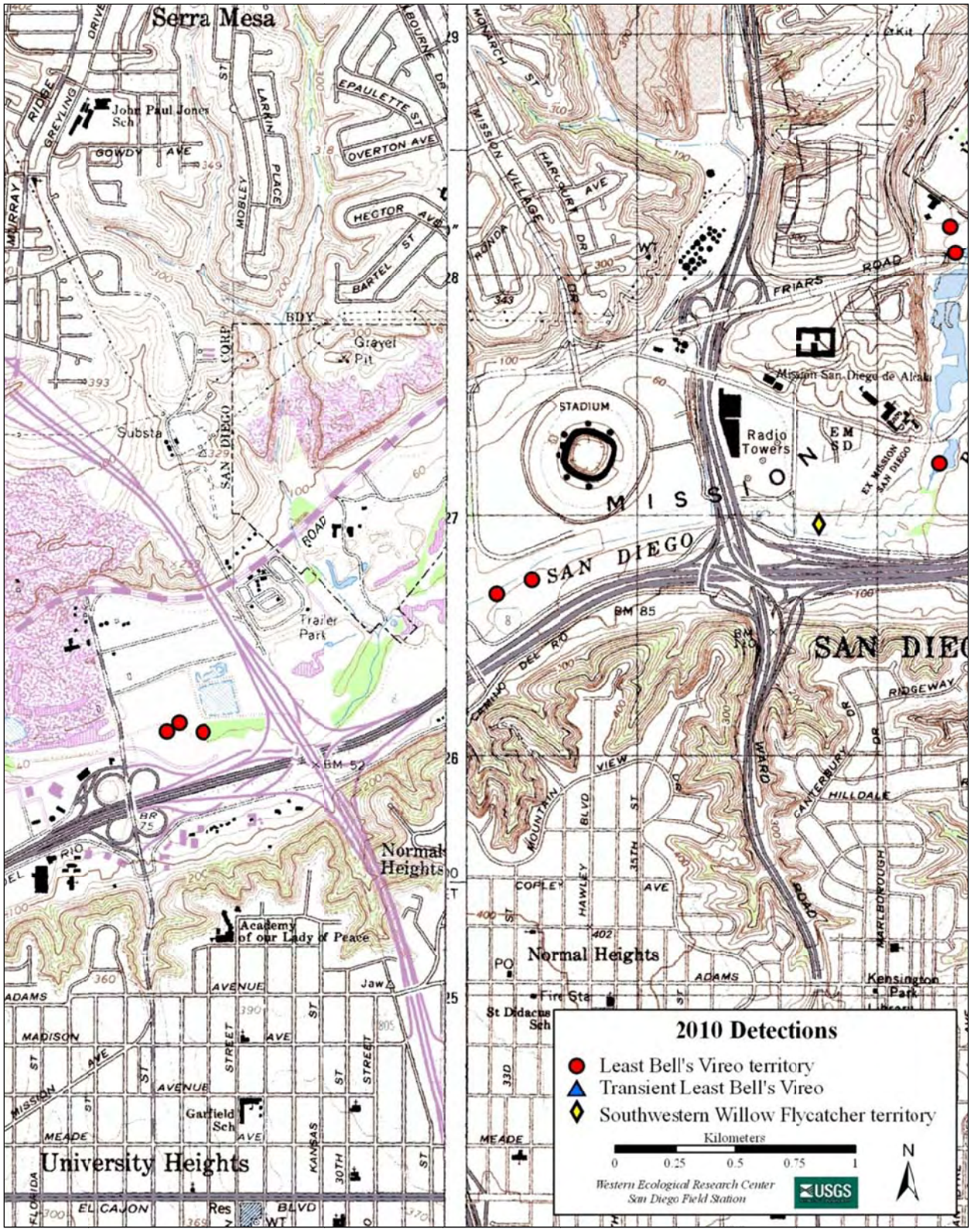

Fig. 13. Locations of Least Bell's Vireos along the San Diego River, 2010: east Valley.

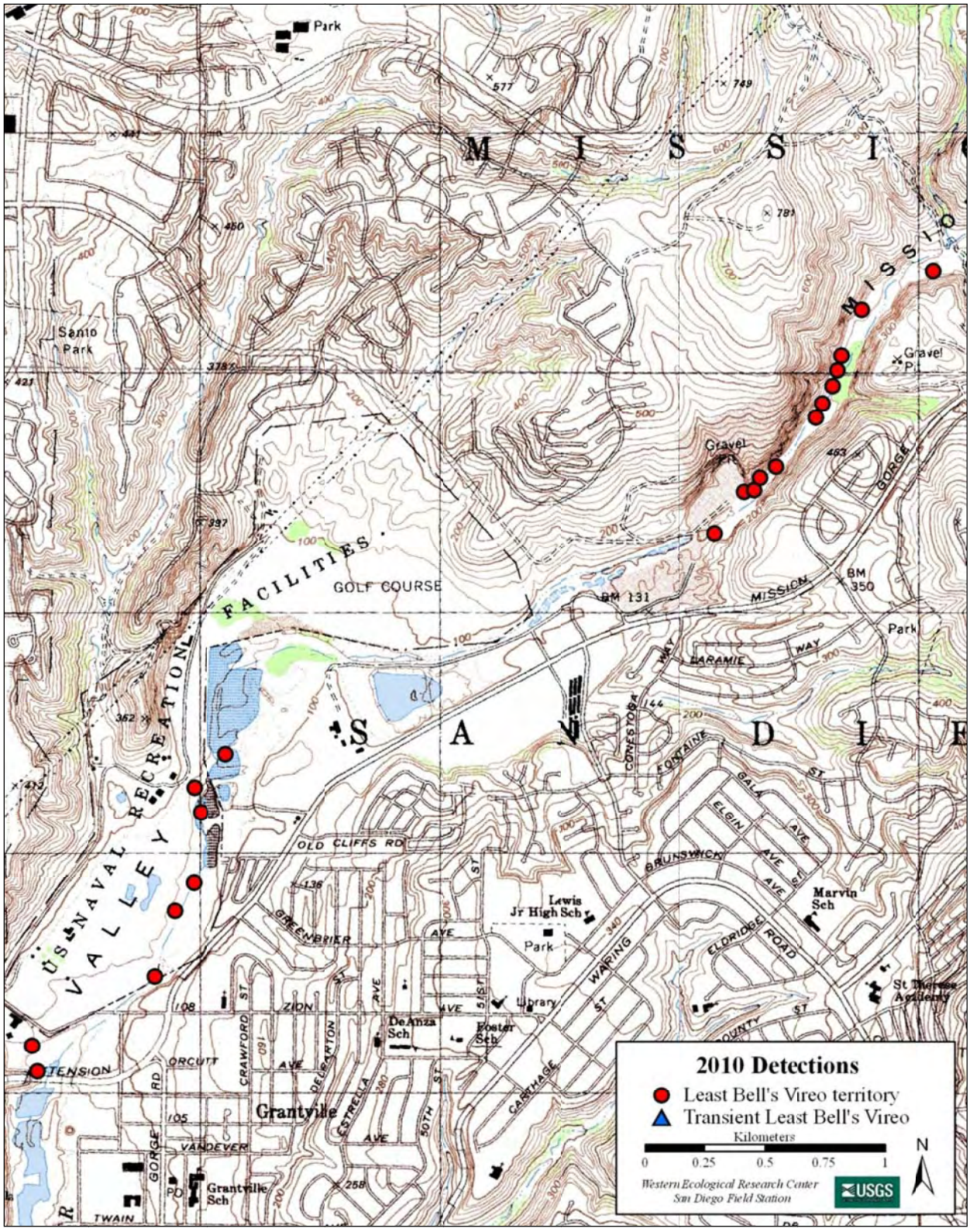

Fig. 14. Locations of Least Bell's Vireos along the San Diego River, 2010: Gorge.

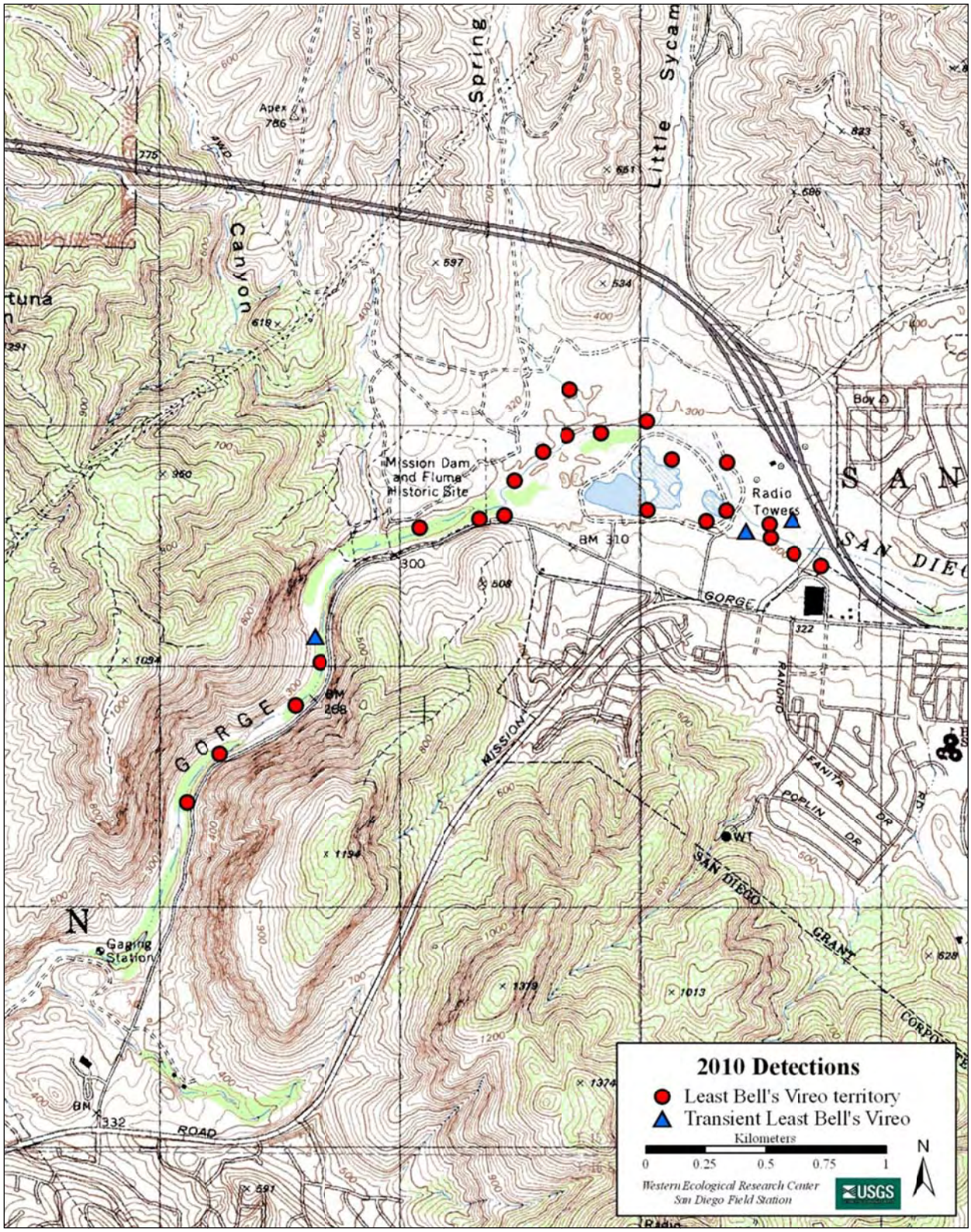

Fig. 15. Locations of Least Bell's Vireos along the San Diego River, 2010: upper Gorge and Park.

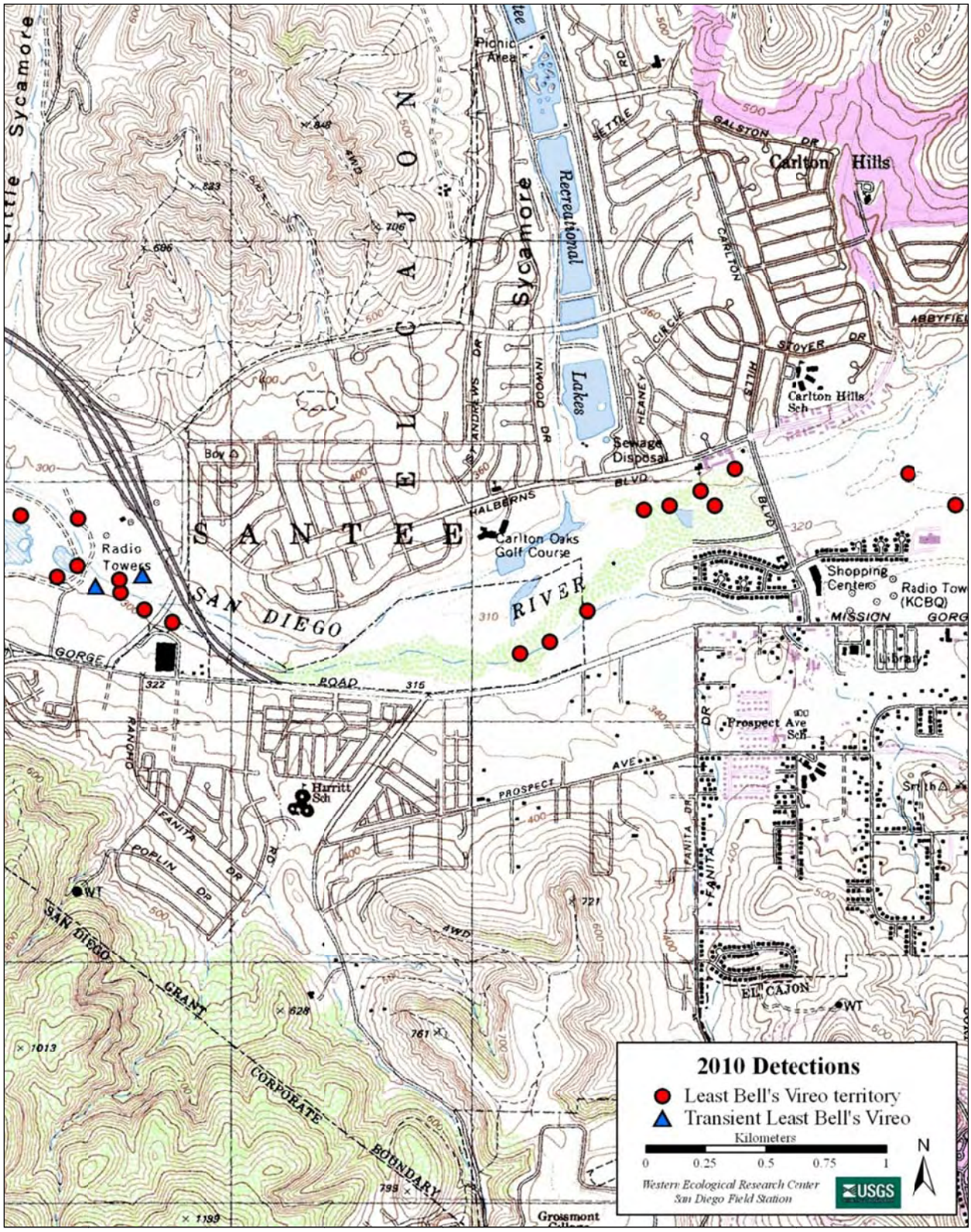

Fig. 16. Locations of Least Bell's Vireos along the San Diego River, 2010: east Park and west Santee.

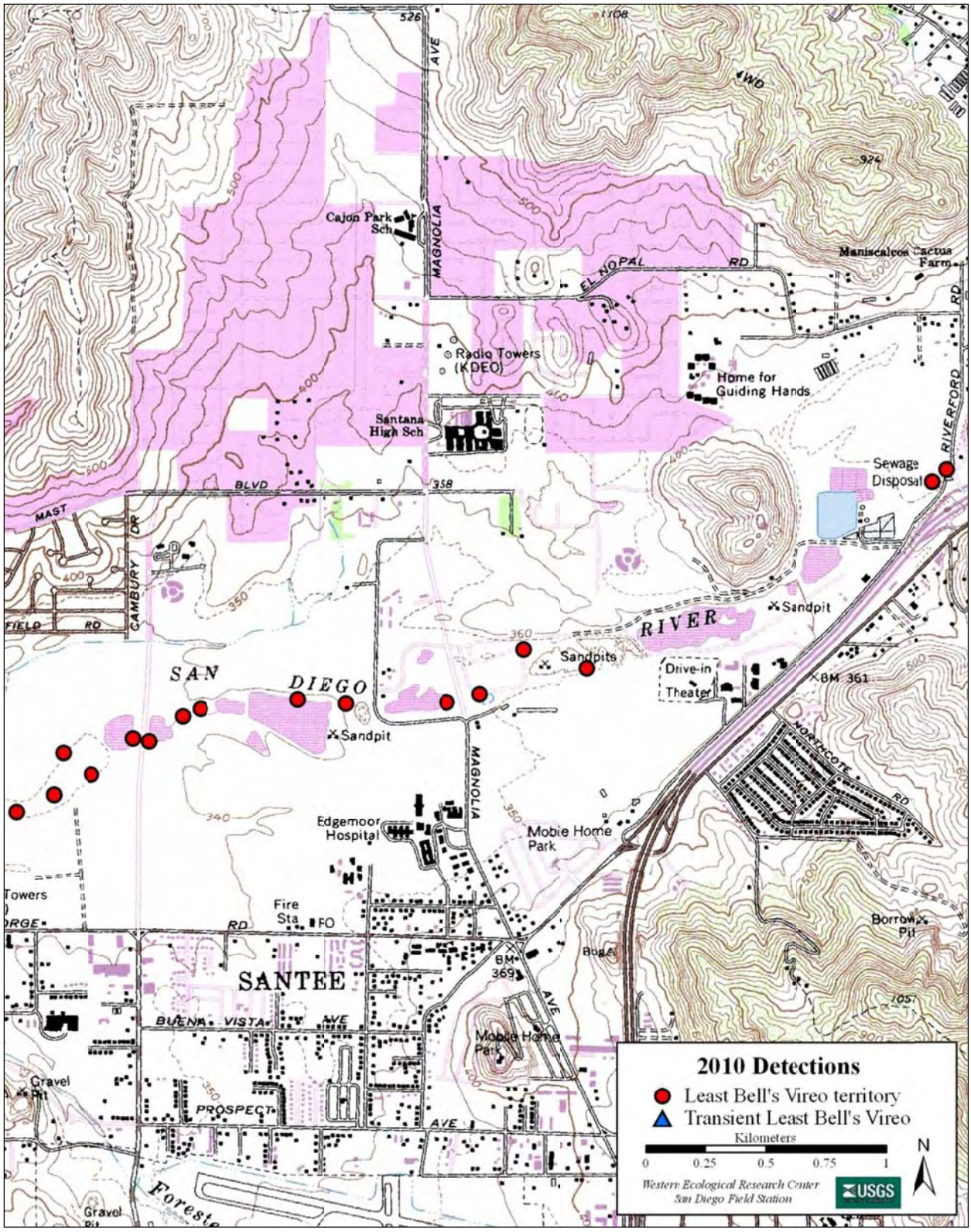

Fig. 17. Locations of Least Bell's Vireos along the San Diego River, 2010: Santee.

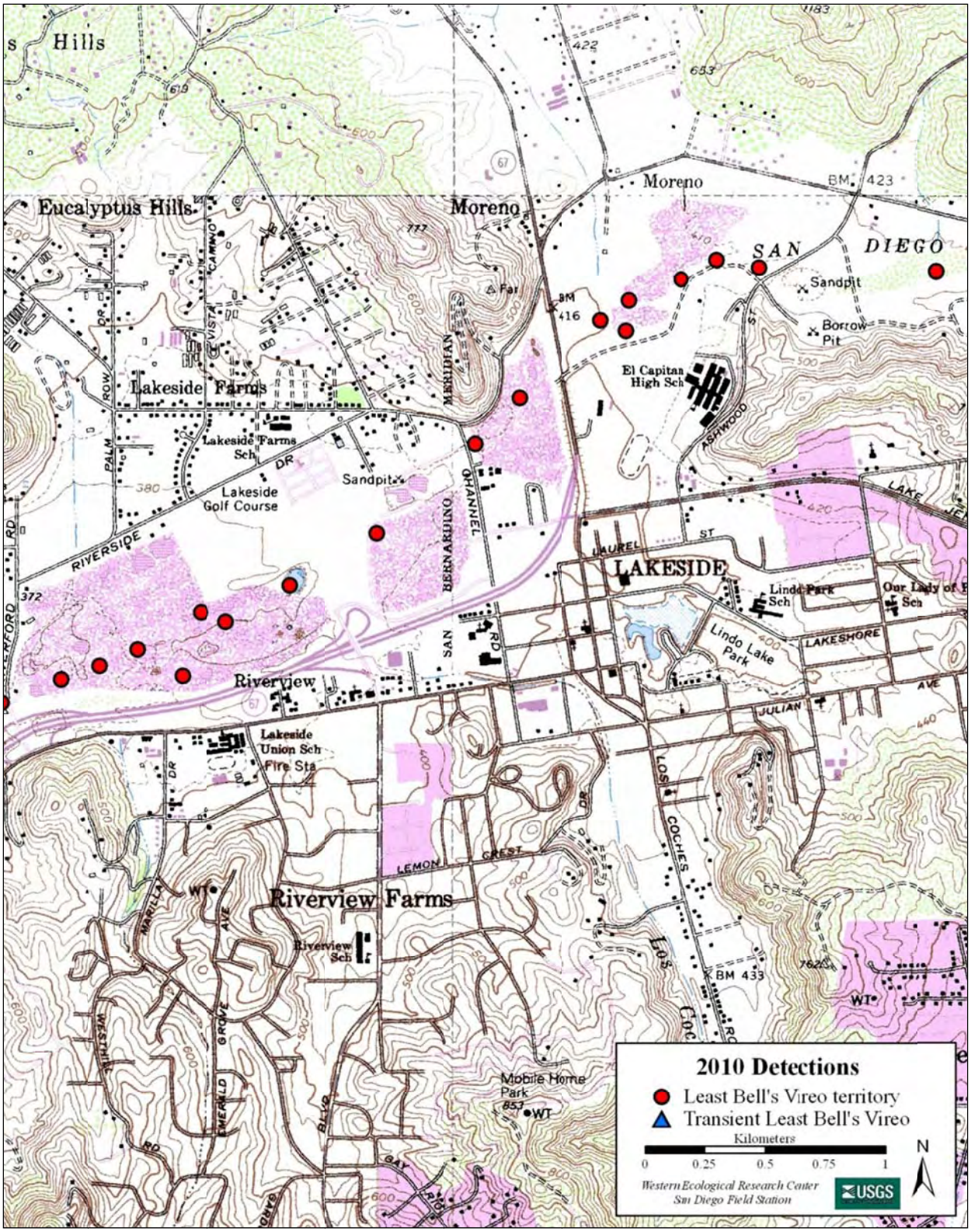

Fig. 18. Locations of Least Bell's Vireos along the San Diego River, 2010: Lakeside and west El Capitan.

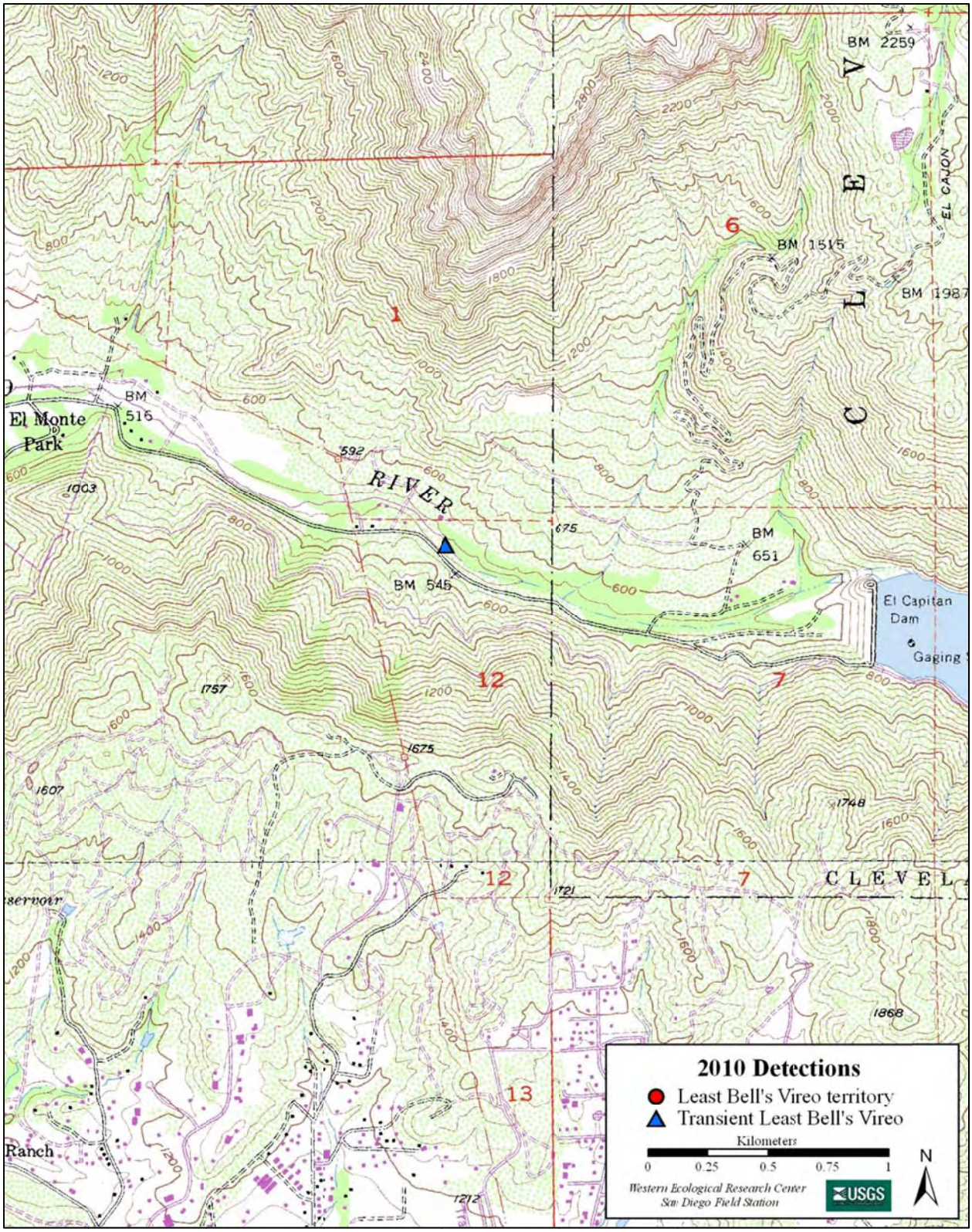

Fig. 19. Locations of Least Bell's Vireos along the San Diego River, 2010: east El Capitan.

APPENDIX C

STATUS AND NESTING ACTIVITIES OF LEAST BELL'S VIREOS ALONG THE SAN DIEGO RIVER, 2010

TREATMENT SITE TERRITORIES					
Territory	**Nest**	**Nest Fate[a]**	**# Cowbird Eggs**	**# Fledged**	**Comments**
BTN	1	PRE			
CCO	1	SUC		3	
CL6	1	PRE			
CL6	2	SUC		2	
EDD	1	PRE			
EDD	2	PRE			
EDD	3	UNK			Nest abandoned, no eggs observed.
FJS2	1	FAL			Nest not completed.
FJS2	2	SUC		4	
FJS2	3	SUC		4	
FRE	1	PRE			
FRE	2	PRE			
FRE	3	PRE			
FRE	4	PRE			
HTS	1	SUC		4	
HTS	2	PRE			
SGMD	1	SUC		1	
SGMD	2	PRE			
SGMD	3	PRE	1		
SGPN	1	PRE			
SGPN	2	SUC		4	
SGPP	1	INC			Nest not completed.
SGPP	2	PRE			
SGPP	3	PRE			
SGPP	4	SUC		3	
SGSO	1	PRE			
TOW	1	SUC		3	
TOW	2	PRE			
WMB2	1	PRE			
WMB2	2	SUC		3	

[a] Nest Fate: INC = nest never completed; SUC = fledged at least one Least Bell's Vireo young; PRE = nest failure caused by predation; PAR = nest failure caused by Brown-headed Cowbird parasitism; OTH = reason for nest failure known, such as substrate failure; UNK = reason for nest failure/abandonment unknown.

REFERENCE SITE TERRITORIES

Territory	Nest	Nest Fate[a]	# Cowbird Eggs	# Fledged	Comments
ALT	1	UNK			Nest abandoned with eggs.
ALT	2	PRE			
JOY	1	INC			Nest not completed.
JOY	2	PRE			
JOY	3	SUC		1	
LIB	1	PAR	2		
LIB	2	PRE	1		
LIB	3	PAR	3		
POR	1	UNK			Nest abandoned, no eggs observed.
POR	2	OTH			Nest support branch failed.
POR	3	PRE			
POR	4	SUC		3	
SGCA	1	PRE			
SGCA	2	SUC	1	3	
SGCH	1	OTH			Nest destroyed by humans (homeless camp).
SGCH	2	PRE			
SGCH	3	UNK			Nest destroyed possibly by humans, contents still present.
SGCH	4	PRE			
SGFU	1	PRE			
SGMA	1	UNK			Nest abandoned, no eggs observed.
SGMA	2	PRE			
SGMA	3	PRE			
SGSA	1	UNK			Nest abandoned with eggs.
SGSA	2	UNK			Nest abandoned with eggs.
SGSA	3	UNK			Nest abandoned, no eggs observed.
SGSA	4	SUC	2	2	
SGSA	5	PAR	1		
SPR	1	PRE			
SPR	2	PRE			

[a] Nest Fate: INC = nest never completed; SUC = fledged at least one Least Bell's Vireo young; PRE = nest failure caused by predation; PAR = nest failure caused by Brown-headed Cowbird parasitism; OTH = reason for nest failure known, such as substrate failure; UNK = reason for nest failure/abandonment unknown.